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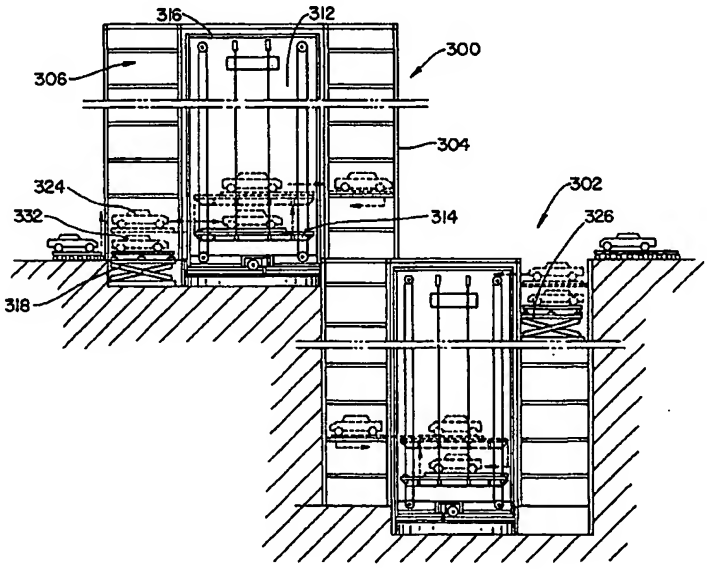

(57) Abstract

An improved automated parking garage structure which includes both above ground and below ground components. Each of the components is formed from a cylindrical multilevel housing. Each level of the housing includes a plurality of radially arranged parking stalls (12). The stalls of each component are serviced by an elevator with a centrally disposed telescopic platform. The entire elevator can be rotated by way of an elevator tower. Both the above ground and below ground components are accessed via transfer lifts (14). The lifts (14) are used in transporting a vehicle from ground level to the elevator platform (18) and vice versa. Operation of the transfer lift (14), elevator and tower are coordinated by an automated control system.

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IMPROVED VEHICLE PARKING STRUCTURE

Background of the Invention

1. Field of the Invention

The present invention relates to a vehicle parking system, and more particularly to a fully automated parking system.

2. Description of the Prior Art

As a result of the increasing scarcity of land space, and increasing costs of labor, it is becoming more and more difficult to provide sufficient parking spaces and facilities, particularly in urban areas. In the present inventor's U.S. Patent No. 3,497,087 of February 24, 1970, there is disclosed an innovative parking system utilizing a circular tiered construction having a radial parking configuration for vehicles, in which the vehicle stalls are arranged circumferentially about an inner elevator structure. Such a general system contemplated significant economies in both site utilization and operation.

The present invention is an improvement to the invention, and further refines and modifies the general concepts disclosed therein. The features and benefits of such an improved parking structure include efficiencies in vehicle positioning and entry/exit from the structure, automated location identification and vehicle loading and retrieval, improved stability of the structure and improved safety.

Summary of the Invention

It is therefore an object of the invention to provide an automated parking system which allows for both above and below ground parking.

It is another object of the invention to employ independent transfer assemblies so that simultaneous parking above and below ground can be achieved.

If is a further object of the present invention to provide two rotatable elevator towers which can each service a plurality of individual parking stalls.

It is still another object of the invention to provide a fully automated garage wherein vehicles can be parked with little or no human interaction.

These and other objects of the invention are achieved by an automated parking garage which includes both an above ground component and a below ground component. These two components are interconnected and at least partially disposed over one another. Each of the components is formed from a cylindrical multilevel housing with each level

including a plurality of radially arranged parking stalls. Additionally, each parking stall has a floor formed from a plurality of inwardly disposed fingers for supporting the wheels of a vehicle and each of the housings has a centrally disposed elevator which is adapted to be raised and lowered to anyone of the levels of the housing.

Furthermore, each elevator of the garage has a centrally disposed platform with first and second extension carriages slidably mounted thereon. In this manner, the first extension carriage can travel between the first and second ends of the platform, and the second extension carriage can be cantilevered from the first and second ends of the first extension carriage. Each of the second extension carriages is formed from a frame having a plurality of transverse bars mounted thereon. These bars are spaced such that each second extension carriage can pass through the floor of an associated stall, with the bars of the second extension carriage being interdigitated with the fingers of the stall floor.

Each of the housings of the garage also has an elevator tower for supporting the associated centrally disposed elevator. The elevator towers are each adapted for rotation within its associated housing. A first transfer lift is positioned within the bottom level of the above ground component. The first transfer lift has a first lower level wherein a vehicle can be driven onto the lift, and a second upper level wherein the vehicle can be retrieved by the second extension carriage of the elevator. The first transfer lift also has a main plate with a plurality of outwardly directed fingers formed along lateral edges. The first transfer lift additionally includes a lift platform frame which has a plurality of inwardly directed fingers which are spaced to be interdigitated with the fingers of the main plate. Thus, the main plate and the lift platform frame are interdigitated and in planar alignment with the transfer lift in the lower level. Conversely, the lift platform frame is positioned above the main plate with the transfer lift at the second level. The second transfer lift is positioned within the top level of the below ground component. The second transfer lift likewise has a first upper level wherein a vehicle can be driven onto the lift, and a second lower level wherein the vehicle can be retrieved by the second extension carriage of the elevator.

Brief Description of the Drawings

A fuller understanding of the present invention and the features and benefits thereof will be accomplished upon review of the following detailed description together with the accompanying drawings, in which:

FIG. 1 is a sectional schematic view of an improved vehicle parking structure in accordance with the present invention;

FIG. 1A is an alternative embodiment to the vehicle parking system depicted in FIG 1.

FIG. 1B is another alternative embodiment to the vehicle parking system depicted in FIG 1.

FIG. 1C is another alternative embodiment to the vehicle parking system depicted in FIG. 1.

FIG. 2 is a schematic top plan view of FIG. 1;

FIG. 3 is a detailed depiction of the vehicle elevator portion of the invention;

FIG. 4 is a depiction of the vehicle transfer lift oriented in the lowered position, with the raised position being depicted in phantom;

FIG. 5 is a depiction of the vehicle transfer lift in the raised position with the transfer carriage of the elevator being extended to mate therewith;

FIG. 6 is a depiction of the elevator in alignment with a parking stall in connection with the transfer of a vehicle to the stall;

FIG. 7 depicts the deposit of a vehicle in a stall by the elevator;

FIG. 8 is a detailed view in section taken along line 8-8 of FIG. 7 depicting the elevator platform;

FIG. 9 is a top plan view of the elevator turntable;

FIG. 10 is a plan view in section taken along line 10-10 of FIG. 9;

FIG. 11 is a representation of an alternative elevator lift mechanism;

FIG. 12 is a top plan view of the platform of the external vehicle lift unit; and

FIG. 13 is a top plan view of a parking stall with the elevator carriage extended into alignment therewith during a vehicle transfer process.

FIGS. 14A-E are flow charts which are helpful in understanding the operation of the automatic storage operating system.

FIGS. 15A-D are flow charts which are helpful in understanding the operation of the automatic retrieval operating system.

FIG. 16 is a plan view of the vehicle parking structure depicting the program cell numbers referenced in the flow charts.

FIG. 17 is a perspective view of a rectangular vehicle parking structure.

FIG. 18 is a plan view of the elevator platform employed by the rectangular vehicle parking structure of embodiment of FIG. 17.

FIG. 19 is a plan view of one level of the rectangular vehicle parking structure of FIG. 17.

FIG. 20 is an elevational view of the automated boat storage embodiment of the present invention.

FIGS. 21-24 are perspective views of the boat storage elevator and associated lifting means.

FIGS. 25-26 are elevational views of the lifting means of the boat storage elevator.

FIG. 27 is a more detailed view of the lifting means of the boat storage elevator.

FIG. 28 is an elevational view depicting an individual boat stall with associated supports.

FIG. 29 is a perspective view of a trailer support for use in conjunction with the automated boat storage embodiment.

FIG. 30 is an elevational view of the modular storage container embodiment of the present invention.

FIG. 31 is a view of the various sized modular containers for use in conjunction with the modular storage container embodiment of the present invention.

Detailed Description of the Preferred Embodiments

With initial reference to Figures 1 and 2, a parking structure 10 in accordance with the present invention may preferably be composed as a multi-story frame structure, each of stories having the capacity to store a plurality of vehicles in a radial manner in a corresponding plurality of parking stalls or locations 12. While Figure 1 depicts a structure having six parking levels it is to be appreciated that the number of levels may be varied without departing from the spirit or scope of the invention. The vehicles are shuttled to and from the parking stalls by central elevator platform 18, which is capable of rotation about a vertical axis as well as vertical motion. The elevator platform includes a telescoping carriage which extends to transfer a vehicle between the elevator platform and a stall, as well as between the elevator and a loading/unloading facility.

Vehicles to be parked are positioned on a loading facility comprising vehicle transfer lift apparatus 14 having a two-part vehicle support surface 16. After the driver and passengers alight from the vehicle, the vehicle lift apparatus extends to the raised position, as shown in phantom in FIG. 1, at which time the carriage of elevator platform 18, which is positioned adjacent the raised position of the lift, extends into a vehicle-receiving position directly below the raised support surface portion 20. The vehicle transfer lift apparatus then withdraws to the down position, the vehicle being supported upon the extended elevator carriage. The elevator carriage is retracted, bringing the vehicle into a central position within the elevator tower as depicted in FIG. 1. The elevator lift is then activated, raising the elevator to the level at which a designated empty stall is available while the tower is simultaneously rotating about a central axis to radially align the elevator platform with the available stall. The elevator carriage supporting the vehicle then extends, positioning the vehicle directly and slightly above the floor of the chosen stall. The elevator platform then descends slightly, transferring the support of the vehicle to the stall floor. The carriage then retracts. The elevator platform can then be rotated and raised or lowered as required for a subsequent operation.

Vehicle withdrawal is performed by an analogous process. In response to an appropriate command, which may, for example, be as the result of a patron inserting an encoded parking ticket into an appropriate validating device, the elevator platform both rises and rotates to be oriented adjacent, and slightly below the floor of the stall of the

vehicle to be retrieved. The elevator carriage extends to underlie the stall floor. The elevator platform then rises slightly to engage the wheels of the vehicle and lift the vehicle from contact with the stall floor. The carriage retracts into the tower, and then descends to the transfer level in alignment with the exit transfer lift apparatus. The elevator carriage again extends and the transfer lift apparatus rises to meet the carriage, removing and raising it slightly from the extended carriage. The carriage then retracts, the transfer lift apparatus returning the vehicle to ground level at which time the operator and other occupants may enter the vehicle and drive it off the lift apparatus and away from the garage.

In order to isolate the driver and occupants of the vehicle from the parking structure, a horizontal shuttle platform system
may be employed to convey vehicles to and from the transfer lifts. Shuttle system 22 includes a shuttle platform 24, typically level with an entrance road, upon which a vehicle to be parked is driven. The operator and occupants exit and lock the vehicle, which is then shuttled horizontally to a position directly above the retracted transfer lift within the parking structure, at which point the transfer lift engages the vehicle, removing it from the shuttle and raising it to the elevator reception level. The shuttle then returns to the starting position. A similar shuttle system 26 may be employed with a second transfer lift 28 for vehicle return. Because the transfer lift raises vehicles from ground level to a first level for receipt by the main elevator platform, the parking structure 10 does not require significant site excavation, the structure being able to be constructed quickly and efficiently on land which is simply graded to level. This may be of significant benefit in areas where the water table is high and excavation requires water control provisions. Configured in the nature of a materials handling system, the structure can be efficiently built and operated.

As perhaps best seen in FIGS. 2 and 3, the elevator system of the present invention includes elevator platform 18, located and supported for transit within elevator tower 22 which is mounted for rotation within the core of the generally cylindrical stall structure 32. As will be discussed in greater detail infra, the elevator tower may include an outrigger structure 34 to provide stability and further support for the tower.

FIGS. 3 and 8 further detail the elevator platform assembly. As shown therein, the platform may preferably comprise main platform frame 36, of a general truss-like construction, on which sits a two-part extension carriage assembly for retrieving vehicles

from both the transfer lift apparatus and parking stalls and for delivering vehicles thereto. Main platform 36 may be formed with a plurality of truss-forming elements 38 supporting main beams 40. Transverse beams 42 are each fixed at their ends to pairs of chain loops 44 which, in conjunction with elevator drive apparatus 46, located at the top of the elevator tower, allows the elevator platform to be raised and lowered as required. Although described as a chain drive, a rack and pinion drive could alternatively be employed. A set of counterweights 50 are connected to the platform by cables 52 which run over pulleys 54, similarly located at the top of the tower, and which terminate at platform beams 48. The counterweights are chosen to balance the weight of elevator platform, as known in the art, to minimize the effective lifting load for the drive apparatus 46. The elevator platform frame 36 supports an extension carriage assembly comprising first and second extension carriages.

First extension carriage 56 is of generally rectangular construction in plan and is of a length substantially equal to that of the platform frame 36. It includes main lateral box beams 58 as seen in FIG. 8 joined by transverse members 60. Upper and lower track plates 62, 64, respectively, are affixed to the box beams. A series of first rollers 66 are mounted on axle studs 68 on the angle irons 70 of the main platform, and are embraced by the track plates 62, 64 extending outwardly from a first side of the first extension carriage's box beams 58. The combination of the plates 62, 64 and the rollers 66 allow the first extension carriage to extend outwardly from the platform frame in a cantilever-type fashion.

Extension/retraction drive for the first extension carriage is provided by a gear track 72 mounted to the underside of , and which extends the length of, the first extension carriage, and which is engaged by a pinion drive gear 74 operated by reversible motor 76 mounted to the platform frame 36. Power for the motor is provided by a cable (not shown) which runs from a junction box 80 on the platform frame (see Fig. 3) to a main power feed unit 82 located at the bottom of the elevator tower. As known in the art, feed unit 82 may include a cable take-up assembly to allow feed of the cable as the elevator platform rises, and take-up of the cable onto a drum as required as the elevator descends.

Second carriage 84 carries a vehicle 86, and is adapted to shuttle the length of the first extension carriage, allowing the receipt of a vehicle from either a parking stall or the

vehicle lift apparatus, the return of a vehicle thereto, as well as centrally positioning the vehicle on the elevator platform during elevator operation. The second carriage includes a plurality of transverse bars 88 positioned and spaced to both support the wheels of the vehicle 86, and to interdigitate with both the parking stall floor elements and the upper portion 20 of support surface 16 of the transfer lift apparatus, as will be further discussed infra. The bars 88 form a frame with, and are affixed to, lateral rails 90.

To permit the shuttle operation of the second carriage, a series of second rollers 92 are mounted to the lateral rails 90 through axle studs 94, and similarly ride upon and between the track plates 62, 64 on a second side of the box beams 58 of the first extension carriage. A second gear track 96 is mounted to the top of first extension carriage and extends along the length thereof. Top carriage reversible drive motor 98 is mounted to the second carriage, and has pinion drive gear 100 which engages with the second gear track 96 to drive the second carriage along the length of the first carriage. A power cable (not shown) connects the drive motor to feed/take-up unit 102 (see Fig. 3) on the elevator platform frame 36. The feed/take-up assembly is in turn coupled to junction box 80.

As depicted in FIGS. 2 and 3, both the main tower and the outrigger 34 ride upon circular track 104 which is rigidly installed at or slightly below ground level, within the inner circumference of the surrounding parking stall structure 32. The track 104 includes a rail 106 upon which the wheels 108, affixed both to the main tower frame and outrigger, ride. A circular gear track 110 is associated with the rail 106, and is engaged by a pinion gear 112 associated with an individual drive motor 114 located proximate a wheel. The wheels, which may be four in number, may each be provided with an associated drive motor and gear.

While the wheels and rail provide primary support and guidance for the elevator tower, additional stability is provided by central mount as depicted in FIGS. 9 and 10. As shown therein, lower structural beams 116 for the tower, and beams 118 for the outrigger, are centrally joined together into a box-like construction encircling central axis 120 about which the tower rotates. The axis is defined by a rigid pipe section 122 vertically mounted into a concrete base 124. Located within the box-like structure formed by the tower and outrigger beams is bearing structure 126, which supports roller bearings 128 against the pipe and assist in maintaining the elevator tower in proper orientation with respect thereto.

The bearing structure may include a pair of parallel-spaced beams between the tower beams 116 and spaced cross-members 132 surrounding the pipe 122 and supporting the roller bearings 128. A circular top plate 134 is mounted to the pipe 122 by gussets 136, and overlies and covers the central box structure plate and roller bearings. A concentric rotating ring plate 138 may be mounted to the tower and outrigger beams. A power cable 140 may be passed through the pipe 122 to power mains to provide power to the tower. An appropriate connection (not shown), including a commutator, as known in the art, may be employed to couple the fixed cable to the rotating tower.

It is contemplated that the tower and elevator, as well as the entire parking structure, be constructed as a material-handling system, using prefabricated elements and subassemblies capable of being bolted or otherwise assembled without the necessity for welding or other expensive construction methods. Initial construction of the tower and elevator, which is free-standing with respect to the surrounding stall structure, can be utilized to house the parking stall structure in an efficient manner.

To avoid extensive excavation and to provide an efficient means for transfer of vehicles to and from the elevator, the transfer lift apparatus 14, as detailed in FIGS. 4, 5, and 12, is an integral part of the parking structure. As presented therein, the transfer lift comprises a fixed frame portion 142 and a lift platform 144 which traverses between a lowered position as shown in FIG. 4, permitting a vehicle to be driven or otherwise placed on the lift, and a raised position as shown in FIG. 5 in which the vehicle is transferred to or from the elevator platform 18.

With additional reference to FIG. 12, the lift platform 144 includes a main lift platform plate 146, generally rectangular in plan, and having dimensions appropriate for the receipt of a vehicle thereon. The lateral edges of the plate are provided with finger-like portions 148 located to correspond to and thus underlie the wheels of a vehicle driven onto the lift. Lift platform frame 150 surrounds the plate 146, its lateral edges having fingers 152 which interdigitate with the fingers of the main plate. When in alignment the main plate 146 and frame 150 form a continuous vehicle support surface.

As best in seen in FIGS. 4 and 5, main plate 146 is supported when the transfer lift is in the lowered position by a series of pads 154 which are mounted to the top ends of

risers 156 of fixed frame 142. The fixed frame 142 is preferably located in a shallow pit or depression such that the pads 154 and thus the main plate 146 are in alignment with a vehicle-reception surface, which may include ramp 158, shown in phantom. The pads are preferably aligned to support the fingers 148 of the main plate.

The lift platform frame 150 is supported by risers 160 which in turn are mounted to a lower generally rectangular frame 162. Lower frame 162 is, in turn, supported by scissor lift assembly 164 and raised and lowered by hydraulic cylinder unit 166. In the lowered position, as depicted in FIG. 4, lift platform frame 150 is co-planar with the main plate 146, thus providing a composite surface aligned with the ramp 158, or other ingress-egress means for the transfer lift. To allow the lift platform to rise to the elevated position depicted in Fig. 5, the main plate 146 is lifted from the pads 154 by the lower frame 162, the main plate being carried by the lower frame until the lift platform is in the fully elevated position as shown in FIG. 5.

Because the transfer lift is located within the confines of the stall structure, it may be desired that a vehicle's occupants exit a vehicle to be parked, and enter a vehicle after return from the structure, remote from the stall structure. This may be accomplished by the inclusion of the shuttle 22 depicted in Figs. 1 and 2 in lieu of the transfer lift ramp 158 depicted in Figs. 4 and 5. As depicted, shuttle 22 may include a shuttle platform 24 exterior to the parking structure 10 which extends or cantilevers on rollers 168 or the like, in a manner known in the art, between an initial position as depicted in Fig. 1 and an extended position in which it overlies the lowered lift platform of transfer lift 142. Appropriate transfer mechanisms may be applied, analogously to the method used to transfer the vehicle between the transfer lift, stalls, and elevator platform, to pass the vehicle to the transfer lift. A second shuttle may be employed in association with a second transfer lift to allow vehicle transfer during an exit procedure simultaneously with the transfer for stall loading.

As depicted in FIG. 3, the elevator platform is raised and lowered by engagement of the drive chain loops 44 about sprockets 170 coupled through transmissions 172 and brake units 198 to one or more drive motors 174. Lower idler sprockets 176, suitably journaled at the lower end of the tower, complete the drive chain loop. The drive sprockets, transmissions and motors are preferably mounted at the top of the elevator tower

and are connected by appropriate cables along the tower for connection with the main feeder cable 140. Alternatively, and as depicted in FIG. 11, operation of the elevator platform may be controlled by a drive system mounted to the elevator platform itself. In such an embodiment, the platform may include a cage-like structure 178. The tower may include a pair of vertical beams 180, 182 extending upwardly the length of the tower. Gear tracks 184 extend the lengths thereof, and are engaged by pinion gears 186, coupled through transmission 188 to a motor 190. Depending on the nature of the motor employed, a second drive unit may be located at a second end of the cage. Power to the motor 190 may be provided by a cable from platform junction box 80.

The stall structure surrounding the elevator tower may be of conventional frame construction, with or without walls. Walls are typically not required, as the parking stalls are filled and emptied automatically, without the presence of personnel within the structure. Each stall is constructed with a finger-like floor structure 196 as depicted in Fig. 13. The fingers 192 extend inwardly from stall sides 194, and are spaced and arranged to interdigitate with the transverse bars 88 of the second extension carriage 84 of the elevator platform. In order to provide sufficient support for the vehicle's wheels, and to minimize possible deformation to the tires as a result of an extended stay in a stall, the fingers 192 may preferably be formed with a flat upper surface on the order of 8 inches in width, spaced 6 inches apart. The elevator carriage bars 88 and the other associated vehicle-engagement elements are suitably dimensioned for compatibility with those dimensions.

Appropriate sensors are employed throughout the system to generate position location data. The sensors may be of the known proximity type, and may be located to provide height and angle (rotation) position for the elevator carriage, and for operational or confirmatory data for carriage extension and transfer lift elevation, as well as to confirm the presence of a vehicle in a stall or an elevator or transfer lift. This data is preferably utilized by a computerized system, typically under microprocessor control, which generates the appropriate commands to the various drive motors in association with both the parking and retrieval of vehicles. The primary operational control signals are gathered and generated by a master control unit located in control room 200, which may be located on tower outrigger 34. When so located, the cables for the tower motor drive, as well as elevator platform operation are fed to the control room, power cable 140 passing

through central pipe 122 powering the control room and thus the tower. Control room 200 may be preferably coupled to a remote control room 202 providing a customer interface. While control room 202 is depicted in Fig. 2 as being located within the parking structure, it may be located a distance therefrom, particularly when the shuttles 22 are employed, to keep patrons away from the structure. Communication between the control room is preferably by radio, each control room being provided with an appropriate transceiver and modem, as known in the art, to allow data to pass therebetween. Control room 202 may include appropriate customer interface equipment, including a payment acceptance terminal, a parking ticket or receipt issuing facility, and a receipt reader or validator. Typically, the payment acceptance terminal would be configured to accept both cash and credit card payments. Alternatively, the remote control room may be manned by operating personnel.

Operation of the system is as follows. In the inactive state, the elevator platform may be in the lowered position, adjacent the transfer lift. The first extension carriage is centered on the elevator platform frame and the second extension carriage is at the end of first extension exterior carriage, adjacent the transfer lift (the "a" side) The transfer lift is in the lowered position.

A vehicle to be parked is driven onto the entrance shuttle 22 or, when a shuttle is not used, directly onto the transfer lift. The vehicle is shut off and locked, since manual intervention throughout the parking process is not required. The occupants of the car exit and proceed to the remote control room 202. Upon appropriate payment a parking receipt is generated. With generation of a receipt, a vacant parking stall is identified and its location referenced to the receipt. Such reference may be internal to the system and may be also encoded on the receipt. With receipt issue, the shuttle transfers the vehicle to the transfer lift. The transfer lift then rises to the position depicted in Fig. 5. The elevator platform 18 rises to the position shown in phantom, with the first and second carriages positioned slightly below the raised lift. Platform frame 150's fingers 152 have separated from the fingers of main plate 146, which is resting on lower frame 162. The extension carriages then extend from the elevator, the transverse bars 88 of the second extension carriage being positioned in an interdigitated alignment with the platform frame fingers 152. The elevator platform then rises slightly, the carriage subsequently retracting to bring

the vehicle within the elevator. The elevator platform then rises and rotates into alignment with the designated stall. Simultaneously, the second carriage shuttles across the first carriage to the opposite ("b") side of the platform. The platform is oriented such that the "b" side is adjacent the chosen stall.

The transfer of the vehicle to the stall is depicted in Figs. 6 and 7. The elevator platform is initially oriented with the first and second carriages slightly above the stall floor 196, with the vehicle nose facing the stall, as the vehicle was passed from the "a" side to the "b" side of the platform. The carriages then extend as shown in Fig. 6, orienting the vehicle directly above the stall floor. The platform frame fingers 152 are oriented to interdigitate with the stall fingers 192. The elevator platform then descends to the lowered position depicted in Fig. 7, transferring the vehicle and depositing it upon the stall fingers. The carriages then retract into the tower, the elevator being positioned for a subsequent activity.

Recovery of a vehicle from a stall occurs with the presentation of a properly validated receipt to the remote control room apparatus. Upon confirmation of the validity of the receipt, and payment of additional fees, if required, the location of the vehicle associated with the receipt is identified, the computer system generating the appropriate lift and rotation commands to the elevator to position itself for vehicle recovery, including the positioning of the second carriage at the "b" end of the platform. The platform is positioned slightly below the stall floor, as shown in Fig. 7, and the carriages extend into proper alignment with the floor fingers. The elevator platform then rises to lift the vehicle from the stall and transfer it to the second carriage. The carriages then retract and the elevator platform returns to a position adjacent the exit transfer lift. During the return the second carriage does not pass to the "a" side of the platform, but rather stays at the "b" side, such that the nose of the vehicle remains oriented out, towards the receiving transfer lift. This allows the vehicle to be driven off in a normal, forward gear, rather than requiring it to be driven in reverse gear.

Deposit of the vehicle upon the exit transfer lift is performed by extending the elevator carriages slightly above the raised transfer lift and lowering the vehicle onto the platform frame fingers. The carriages are then retracted, and the transfer lift lowers,

allowing the vehicle to be either driven off or conveyed by the exit shuttle to a location for receipt and drive off by the owner.

Control Systems

Operating under computer control, an optimum path for elevator platform travel can be developed using techniques known in the art. Similarly, an inventory of available parking stalls can be maintained, allowing the shortest load/unload time to be utilized at any particular time and occupancy level. To insure proper operation redundant systems can be employed, and manual overrides provided. The details of the control systems employed in storing and retrieving vehicles are described below in conjunction with Figures 14a-14e; 15a-15d; and Figure 16.

Automatic Storage Cycle Sequence

The control system employed in vehicle storage is described in conjunction with the flow charts of Figures 14a-e. These Figures represent some of the more pertinent features of the control system of the present invention. Additionally, Figure 16 is a plan view of the parking structure which illustrates the program cell numbers referenced in the flow charts of Figures 14a-e and 15a-e. With reference to Figure 14a, the initial storage sequence is illustrated. The sequence is initiated by the user pressing the "store vehicle" option. Subsequently, as indicated by block 400, the user enters a password. The password database is then searched. Decision block 402 illustrates the consequences of a correct or an incorrect password. Specifically, block 404 illustrates that a Personal Identification Number is generated upon entry of a correct password. At an incorrect password, the system defaults back to the store screen mode of block 400.

Once the P.I.N. number is generated the control system selects both a storage target level and a target cell. Figure 14b is helpful in describing this process. The storage target level is determined at block 406, and the storage target cell is determined at block 408. Block 408 employs a hierarchy of target cells in its determination in order to optimize retrieval. Namely, the target cells (note figure 405 of Figure 16) are selected in the following sequence: 4,3,5,2,6,7,1,8,9,16,10,15,11,14,12,13. As a consequence of these two determinations, both a target cell and a target level are selected.

Next, the control system initiates the retrieval of the vehicle to be stored. As illustrated at block 412 this involves: raising the entrance lift; extending the carriage to side

B (noted in Figure 16); then raising the elevator to the upper position; and then centering both the lower and upper slides. The motions required to bring the vehicle to both the target level and cell are next determined. More specifically, the required elevator motion is determined at block 414; the required vehicle orientation is determined at 416; and the distance to the target cell is determined at 418. Additionally, motion speeds (ie. low, medium or high) are determined relative to the elevator motion of block 414 and the tower rotation of 418.

As described in conjunction with block 422, once the target position is obtained the vehicle is positioned within the stall. Namely, the upper and lower slides are extended to either side A or B of the elevator; the elevator is then lowered to position the vehicle within the stall; the slides are then centered. Lastly, the system is returned to the home position. This involves three movements, described in blocks 424, 426 and 428. Block 424 describes the elevator motions and speeds employed to bring the elevator back to the first level; Block 426 describes the lowering the of entrance lift; and block 428 describes the tower rotation and speed needed to bring the tower in alignment with the entrance.

Automatic Retrieval Cycle Sequence

The initial retrieval sequence is illustrated in conjunction with the flow chart of Figure 15a. Block 432 illustrates the retrieval screen into which a user enters their P.I.N. number. The P.I.N. number is verified at decision block 434. Upon entry of a valid password, the cell number and level associated with the P.I.N. are determined. The control system then determines the target cell and level, note Figure 15b. More specifically, the appropriate elevator motion is determined at block 438; the appropriate vehicle orientation is determined at block 442; and the appropriate tower movement is determined at block 444. Furthermore, for blocks 438 and 444, appropriate speeds are also determined based upon how far the elevator, or tower, has to travel. The vehicle retrieval and pick up are best described in conjunction with the flow chart in Figure 15c. Block 446 notes the retrieval steps: extending the upper slide; extending the lower slide; raising the elevator; centering the lower slide; and centering the upper slide. The subsequent movement to the exit cell is performed at blocks 448 and 452. Namely, block 448 represents the determinations needed to bring the elevator to the fist level raised position.

Block 452 represents the determinations needed to efficiently rotate the tower to the exit cell.

The vehicle delivery steps are best described in conjunction with the flow chart in Figure 15d. Specifically, block 454 illustrates the steps performed to present the vehicle for delivery: extension of the upper slide; extension of the lower slide; lowering the elevator; centering the lower slide and centering the upper slide. The home position of the vehicle parking system is signified by block 456. Namely, upon delivery of the vehicle the tower is rotated counter clockwise two cells; the exit lift is lowered; and the upper slide is extended to side B as signified in Figure 16.

Above and Below Ground

Automated parking structures employing both above and below ground components are illustrated in Figure 1a-c. Each of these embodiments adds an underground parking component to the above ground embodiment depicted in Figure 1. The primary advantage gained in the alternative embodiments comes from the use of independent loading facilities. Thus, in each of the alternative embodiments simultaneous above and below ground parking can be achieved.

In the alternative embodiment of Figure 1a the above ground component 300 is partially disposed over the below ground component 302. Additionally, the alternative embodiment of Figure 1b illustrates an upper component 300 which is completely above, and in alignment with, the below ground component 302. This is the only structural difference between the embodiments of Figures 1a and 1b. Thus, because these two embodiments are identical in most respects, only one will be described in detail. Additionally, the same reference numbers will be used in describing like components.

With reference to Figure 1a, one of the alternative parking embodiments is depicted. As indicated, this alternative embodiment employs both an above ground component 300 and a below ground component 302 which are interconnected to one another. Both components include a cylindrical multilevel housing 304. These housings 304 have a plurality of radially arranged parking stalls 306 formed into each of its levels. Additionally, as described in conjunction with Figure 13 of the primary embodiment, each parking stall 306 includes a floor 308 which is formed from a plurality of inwardly disposed fingers. Such fingers are utilized in supporting the wheels of a vehicle.

Each of the housings 304 also employs a centrally disposed elevator 312 which is adapted to be raised and lowered to any of the levels of the housing 304. These elevators 312 are illustrated in both Figures 1a and 1b. Each of the elevators 312 operates independently such that the upper and lower components can be separately serviced. As with the elevator of the primary embodiment, the elevators 312 of the alternative embodiments each have a centrally disposed platform 314 with first and second extension carriages slidably mounted thereon. The first extension carriage is mounted for travel between the first and second ends of the platform and can be cantilevered from the platform frame in a manner more fully described in conjunction with the primary embodiment. Additionally, the second extension carriage is adapted for movement relative to the first and can also be cantilevered.

Each second extension carriage utilizes the construction depicted in Figure 13. More specifically, each second extension carriage is formed from a frame with a plurality of transverse bars mounted thereon. The bars are spaced such that each second extension carriage can pass through the floor 308 of an associated parking stall 306 with the bars of the second extension carriage being interdigitated with the fingers of the stall floor. Through such an arrangement, each extension carriage can deposit or retrieve a vehicle from any one of the levels of its associated housing 304. Furthermore, due to the above ground and below ground components, the two second extension carriages of each embodiment can pass one another on different vertical planes.

With continuing reference to Figures 1a and 1b, the upper and lower components also include elevator towers 316. Such towers 316 are used to support the associated centrally disposed elevator 312. Each elevator tower 316 is adapted for rotation within its associated housing 304 in a manner more fully described in conjunction with the primary embodiment. Through such rotation, the extension carriages can be positioned to service any of the radially arranged stalls 306. Additionally, the elevator towers 316 of the upper and lower components operate independently of one another to enable simultaneous above and below ground parking.

Two transfer lifts service each component of the parking garage. Namely, a first set of transfer lifts 318 service the above ground component 300, while a second set of transfer lifts 326 service the below ground component 302. In this manner, one vehicle

can be positioned onto a transfer lift while another is being transferred between the other lift and the elevator platform. The arrangement of the two lifts with respect to the associated component is most clearly illustrated with reference to Figure 2. Additionally, as indicated in conjunction with the primary embodiment, shuttle platforms can be used in conveying vehicles to and from the transfer lifts.

The above ground transfer lifts 318 are positioned within the bottom level of the above ground component 300 in a manner depicted in Figures 1a and 1b. These two transfer lifts 318 are of an identical construction. Each above ground lift has a first lower level wherein a vehicle can be driven onto the lift, and a second upper level wherein the vehicle can be retrieved by the second extension carriage of the elevator. Additionally, as described in conjunction with the primary embodiment, each above ground lift has a main plate 146 with a plurality of outwardly directed fingers 148 formed along its lateral edges. Each above ground lift also has a lift platform frame which has a plurality of inwardly directed fingers 152 which are spaced to be interdigitated with the fingers 148 of the main plate. As illustrated in Figure 12, the main plate 146 and lift platform frame 150 are interdigitated and in planar alignment when the associated transfer lift is at the lower level. The lift platform frame 150, however, is positioned above the main plate with the associated transfer lift at the second level. This raised orientation of the transfer lift is illustrated with reference to Figure 5. The raised orientation enables a vehicle to be retrieved from the transfer lift by way of a second extension carriage. A more detailed description of this operation is provided in conjunction with the primary embodiment. The second transfer lifts service the below ground component. With reference to Figures 1a and 1b, these lifts are positioned within the top level of the below ground component. Each second transfer lift has a first upper level wherein a vehicle can be driven onto the lift, and a second lower level wherein the vehicle can be retrieved by the second extension carriage of the elevator.

Another above and below ground parking structure is illustrated in Figure 1c. This embodiments employs both an above ground component 300 and a below ground component 302. This embodiment can be similar in overall structure to the circular embodiments described in conjunction with Figures 1a and 1b, or can be similar in overall structure to the rectangular embodiment shown in Figure 17, however, no upper and lower

transfer lifts are employed. Rather, the embodiment of Figure 1c utilizes first and second ramps, 332 and 334 respectively. Ramp 332 extends upwardly 1/2 of a parking level, and ramp 334 extends downwardly 1/2 of a parking level. Thus, a vehicle to be loaded into the above ground component 300 would be driven up ramp 332 and into a position to be retrieved by the extensible carriage of the above ground elevator. A vehicle to be loaded into the below ground component 302 would be driven down ramp 334 and into a position to be retrieved by the extensible carriage of the below ground elevator. Thus, through the use of independently operable elevators and tower structures, simultaneous above and below ground parking can be achieved. It should be noted that the elevator structure is advantageously such that elevators operating at the highest level of the below-ground portion do not interfere with elevators operating at the lowest level of the above-ground portion, and vice versa.

Rectangular Housing

A rectangular embodiment 500 of the automated parking structure is depicted in Figure 17. This rectangular embodiment 500 employs many of the same inventive features of the above described embodiments. Figure 17 illustrates the rectangular housing 502 into which a number of different parking stalls 504 are formed. As with the primary embodiments, each of these individual stalls 504 includes a floor formed from a plurality of inwardly directed fingers 506. These fingers 506 are adapted to support a vehicle within the stall 504.

An elevator tower 508 is centrally positioned within the parking structure and is adapted for liner movement within its interior. Although only one such tower is described in detail, it is within the scope of the present invention to employ two towers to thereby decrease the vehicle loading and unloading times. In the preferred embodiment, the tower 508 is powered through a rack and pinion drive. More specifically, a rack 512 is centrally formed along the length of the structure floor. This rack 512 engages a powered pinion 514 of the elevator tower 508. The powered rotation of the pinion 514 thus serves in moving the elevator tower 508 along the length of the structure. The drive motor for the pinon(not shown)is preferably located upon, and travels with, the tower structure 508. For increased stability, the tower also rides upon adjacent rails 516.

With reference to Figure 18, the elevator platform 518 of the rectangular embodiment 500 is depicted. The elevator platform 518 employs first and second extensible carriages, 522 and 524 respectively. Each of these carriages is formed from a plurality of vehicle supporting fingers 526. Furthermore, each of the two carriages (522 and 524) is independently extensible in either a forward or rearward direction. In other words, the first carriage 522 can be extended forwardly while the second carriage 524 is extended rearwardly, or vice versa. Each of the carriages is adapted to be driven by a rack and pinion drive. These independently operable carriages provide for decreased vehicle loading and unloading times. Furthermore, in a fashion similar to the primary embodiment, the fingers 526 of each carriage are adapted to be interdigitated with the fingers 506 of the stall floors to facilitate vehicle loading and unloading. More specifically, either of the carriages can be extended under a stall floor and then subsequently raised to transfer a vehicle to the elevator platform 518. Alternatively, either of the carriages can be extended over a stall floor and subsequently lowered to transfer a vehicle to a stall floor. With continuing reference to Figure 18, the pinions 528 of the elevator platform 518 are depicted. There are four such pinions 528 in the preferred embodiment, and they ride upon a circular track 532. Thus, through driving one, or all, of the pinions 528 the entire elevator platform 518 can be rotated. The drive motors for the pinions (not shown) are preferably secured to the elevator platform 518. Rotation may be desired to enable the proper vehicle orientation within a particular stall. Additionally, rotation is necessary if the vehicle entrance is at an angle relative to the orientation of the vehicle stalls.

The raising and lowering of the vehicle platform 518 within the tower is also preferably achieved via a rack and pinion drive. More specifically, four driven pinions (not shown) are interconnected to an elevator platform frame 534. The pinion drive motors (not shown) are preferably positioned upon the platform frame 534. These pinions are engaged with four racks 536 positioned vertically within the elevator tower 508. Thus, the rotation of the pinions results in the raising or lowering of the platform frame 534 (and thereby the platform 518) within the surrounding elevator tower 508. Through the liner movement of the elevator tower 508, the rotational movement of the elevator platform 518, and the vertical movement of the elevator platform frame 534, any of the parking stalls 504 can be accessed. Although the operation of the rectangular embodiment has been described

entirely in conjunction with rack and pinion drives, other drives could be utilized. For example, it is within the scope of the present invention to utilize the chain or cable drives in a manner described in conjunction with the primary embodiment.

Boat Storage

Figures 20-29 depict an automated boat storage structure 600 employing the inventive features of the present invention. This structure employs an outer housing 602 into which a number of different boat stalls 604 are positioned. Each of the boat stalls 604 includes four adjustable supports 606. The profile of an individual boat stall 604, with its associated supports 606, is illustrated in Figure 28. Figure 20 illustrates that the housing 602 is preferably positioned within a body of water 608 such that boats can be navigated into the first level of the housing 602. Once within the housing 602, the boats can be transported to one of the stalls 604 in a manner to be more fully described hereinafter.

A rotatable elevator tower 610 is centrally disposed within the outer housing 602 in a manner more fully described in conjunction with the primary embodiment. A boat elevator 612 is supported within the tower 610 and is adapted for vertical movement therein. The boat elevator 612 is shown in detail in Figures 21-24. The elevator 612 includes a platform 614 which supports a pair of guide rails 616. With reference to Figures 23-24, the boat lift 618 is illustrated. This lift 618 is positioned intermediate the guide rails 616 and is adapted for reciprocal horizontal movement therein. More specifically, the lift 618 includes driven channel rollers 622 upon either of its sides. These channel rollers 622 are positioned within the guide channels 616 to thereby permit the movement of the entire boat lift 618 along the length of the elevator 612.

The lift 618 includes a pair of hull arms 624 which are adapted to support a boat. In the preferred embodiment, the hull arms 624 are covered by a soft resilient material to prevent any damage to a supported boat hull. The hull arms 624 can be move into or out of engagement with a boat by way of a motorized scissor jack 626. The motorized jack 626, most clearly illustrated in Figures 25-26, is adapted for vertical movement within a pair of vertical guide channels 628. The upward movement of the jack 626 results in the downward pivoting of the hull arms 624 about stationary rollers 632. Alternatively, the downward movement of the jack 626 results in the upward pivoting of the hull arms 624

about stationary rollers 632. With reference to Figure 27, the rack and pinion drive 634 employed by the jack 626 is depicted.

In operation, a boat destined for storage is navigated into the first floor of the housing. The elevator 612 is then lowered beneath the waterline in preparation for receiving the boat. The boat lift 618 is then extended along the guide rails 616 to bring the hull arms 624 in position beneath the boat. The jack 626 is then brought to a lowered orientation, thereby raising the arms 624 into engagement with the hull of the waiting boat. The elevator 612 is then raised slightly to remove the boat from the water. The boat lift 618 is then retracted and transported vertically to a target level. The tower 610 can also be rotated to properly orient the boat lift 618 with an available stall 604. After the elevator 612 is positioned slightly above a target stall, the boat lift 618 is extended. Then the lift 618 is lowered such that the hull of the boat engages the adjustable supports 606. The hull arms 624 can then be rotated downwardly, and the lift 618 retracted. The boat is now supported upon the adjustable supports of a stall, and the elevator is ready to retrieve another boat.

Modular Storage Container

A modular storage container embodiment 700 employing the inventive features of the present invention is depicted in Figures 30-31. This embodiment, is identical in most respects to the primary embodiment. The structure of Figures 30-31, however, has been specifically adapted to store modular storage units 702. A variety of different sized storage units 702 adapted for use with present invention are depicted in Figure 31. Different numbers of rollers can be used depending on the largest size container. Such storage units 702 can be employed to house a wide variety of items. Once positioned upon the first level, the storage units 702 are adapted to be retrieved and stored in a manner more fully described in conjunction with the primary embodiment.

Mixed Use

It is also within the scope of the inventive arrangements to provide a mixed use garage, wherein differently configured elevators, or modular attachments for the same elevator, can be used to store automobiles, boats, containers and other items. In a mixed use embodiment different ones of the storage locations can be configured for receiving and safely holding different items.

It is to be recognized by those skilled in the art that variations, modifications and adaptations to the embodiments of t he invention set forth herein may be accomplished without deviating from the intended scope of the invention. Accordingly, the invention is to be measured by the scope of the claims annexed hereto.

What is claimed is:

1. An automated parking garage comprising:

an above ground component and a below ground component, the two components being interconnected and at least partially disposed over one another;

each of the components having a multilevel housing with each level having a plurality of parking stalls, each parking stall having a floor formed from a plurality of inwardly disposed fingers for supporting the wheels of a vehicle;

each of the housings having a centrally disposed elevator which is adapted to be raised and lowered to any of the levels of the housing;

each elevator having a centrally disposed platform with first and second extension carriages slidably mounted thereon, such that the first extension carriage can be cantilevered from either end of the platform, and the second extension carriage can be positioned relative to the first extension carriage;

each of the second extension carriages being formed from a frame with a plurality of transverse bars mounted thereon, the bars being spaced such that each second extension carriage can pass through the floor of a stall with the bars of the second extension carriage being interdigitated with the fingers of the stall floor;

each of the housings also having an elevator tower for supporting the associated centrally disposed elevator, each elevator tower adapted for rotation within its associated housing;

a first transfer lift positioned within the bottom level of the above ground component, the first transfer lift having a first lower level wherein a vehicle can be driven onto the lift, and a second upper level wherein the vehicle can be retrieved by the second extension carriage of the elevator;

the first transfer lift having a main plate with a plurality of outwardly directed fingers formed along lateral edges, the first transfer lift also having a lift platform frame which has a plurality of inwardly directed fingers which are spaced to be interdigitated with the fingers of the main plate, the main plate and lift platform frame being interdigitated and in planar alignment with the transfer lift in the lower level, the lift platform frame being positioned above the main plate with the transfer lift at the second level;

a second transfer lift positioned within the top level of the below ground component, the second transfer lift having a first upper level wherein a vehicle can be driven onto the lift, and a second lower level wherein the vehicle can be retrieved by the second extension carriage of the elevator.

2. An automated parking garage comprising:

an above ground component and a below ground component, the two components being interconnected;

each of the components having a multilevel housing with each level having a plurality of parking stalls;

each of the housings having a centrally disposed elevator which is adapted to be raised and lowered to any of the levels of the housing;

each elevator having a centrally disposed platform with at least one extension carriage slidably mounted thereon;

each of the housings also having an elevator tower for supporting the associated centrally disposed elevator, each elevator tower adapted for rotation within its associated housing.

3. The automated parking garage as recited in claim 2 wherein:

each parking stall has a floor formed from a plurality of inwardly disposed fingers for supporting the wheels of a vehicle.

4. The automated parking garage as recited in claim 3 wherein:

the centrally disposed platform includes first and second extension carriages slidably mounted thereon such that the first extension carriage can be cantilevered from either end of the platform, and the second extension carriage can be positioned relative to the first extension carriage;

5. The automated parking garage as recited in claim 4 wherein:

each of the second extension carriages is formed from a frame with a plurality of transverse bars mounted thereon, the bars being spaced such that each second extension

carriage can pass through the floor of a stall with the bars of the second extension carriage being interdigitated with the fingers of the stall floor.

6. The automated parking garage as recited in claim 2 wherein:

the housings of both the above ground component and below ground component are cylindrical with parking stalls being radially arranged on each level.

7. The automated parking garage as recited in claim 2 wherein:

the above ground component is at least partially disposed over the below ground component such that the second extension carriage of each elevator can pass one another on different vertical planes.

8. The automated parking garage as recited in claim 2 further comprising:

a first transfer lift positioned within the bottom level of the above ground component, the first transfer lift having a first lower level wherein a vehicle can be driven onto the lift, and a second upper level wherein the vehicle can be retrieved by the second extension carriage of the elevator.

9. The automated parking garage as recited in claim 6 wherein:

the first transfer lift has a main plate with a plurality of outwardly directed fingers formed along lateral edges, the first transfer lift also having a lift platform frame which has a plurality of inwardly directed fingers which are spaced to be interdigitated with the fingers of the main plate, the main plate and lift platform frame being interdigitated and in planar alignment when the transfer lift is at the lower level, the lift platform frame being positioned above the main plate with the transfer lift at the second level.

10. The automated parking garage as recited in claim 1 further comprising:

a second transfer lift positioned within the top level of the below ground component, the second transfer lift having a first upper level wherein a vehicle can be driven onto the lift, and a second lower level wherein the vehicle can be retrieved by the second extension carriage of the elevator.

11. The automated parking garage as recited in claim 2 wherein:

the above ground component is completely above and in alignment with the below ground component such that the second extension carriage of each elevator can pass one another on different vertical planes.

12. The automated parking garage as recited in claim 1, adapted for storing motor vehicles.

13. The automated parking garage as recited in claim 2, adapted for storing motor vehicles.

14. The automated parking garage as recited in claim 1, adapted for automobiles.

15. The automated parking garage as recited in claim 2, adapted for automobiles.

16. The automated parking garage as recited in claim 1, adapted for boats.

17. The automated parking garage as recited in claim 2, adapted for storing boats.

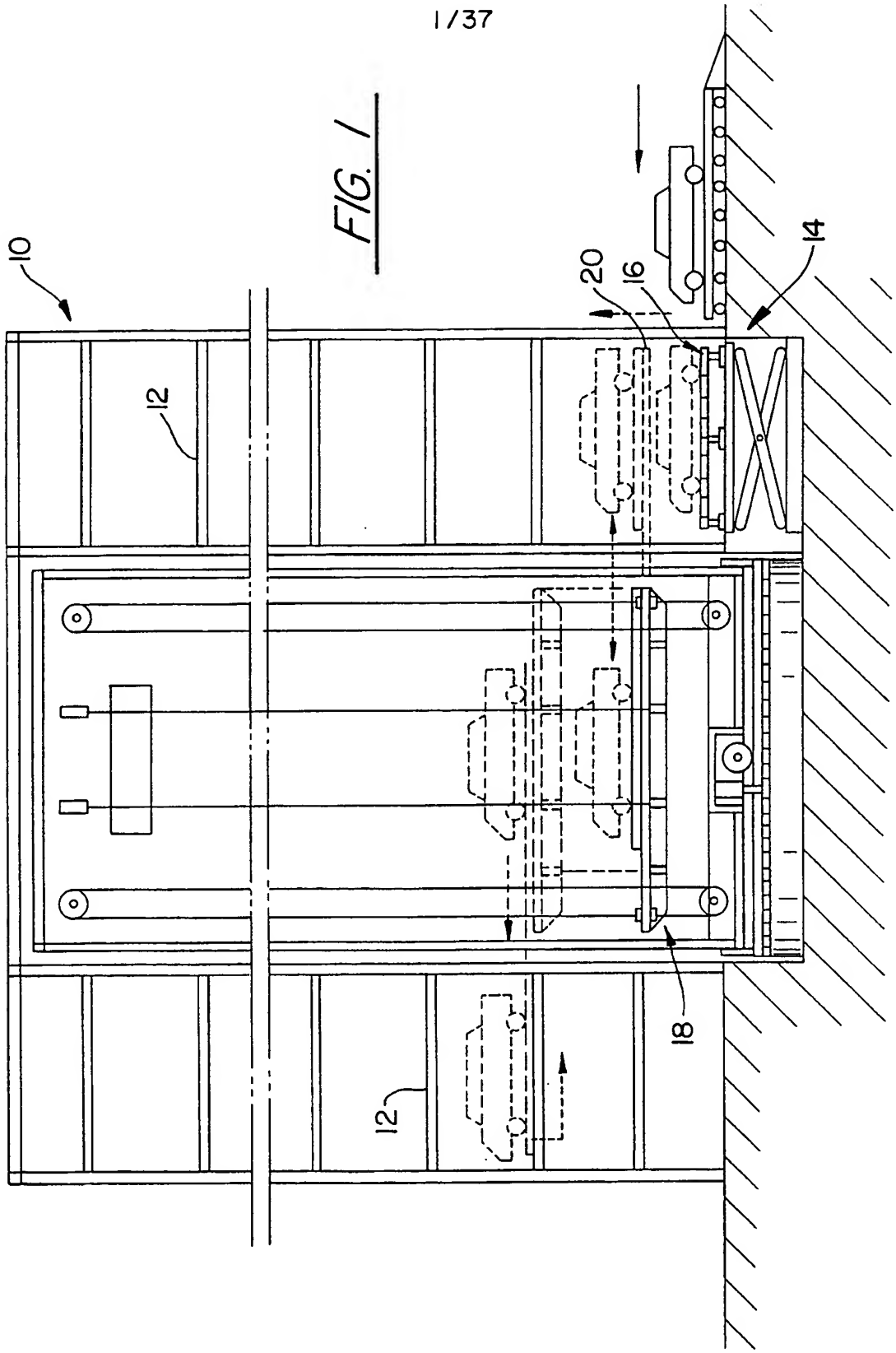
18. The automated parking garage as recited in claim 1, adapted for storing modular storage containers.

19. The automated parking garage as recited in claim 2, adapted for storing modular storage containers.

20. The automated parking garage as recited in claim 1, adapted for storing at least two of motor vehicles, marine vehicles and modular storage containers.

21. The automated parking garage as recited in claim 2, adapted for storing at least two of motor vehicles, marine vehicles and modular storage containers.

FIG. 1



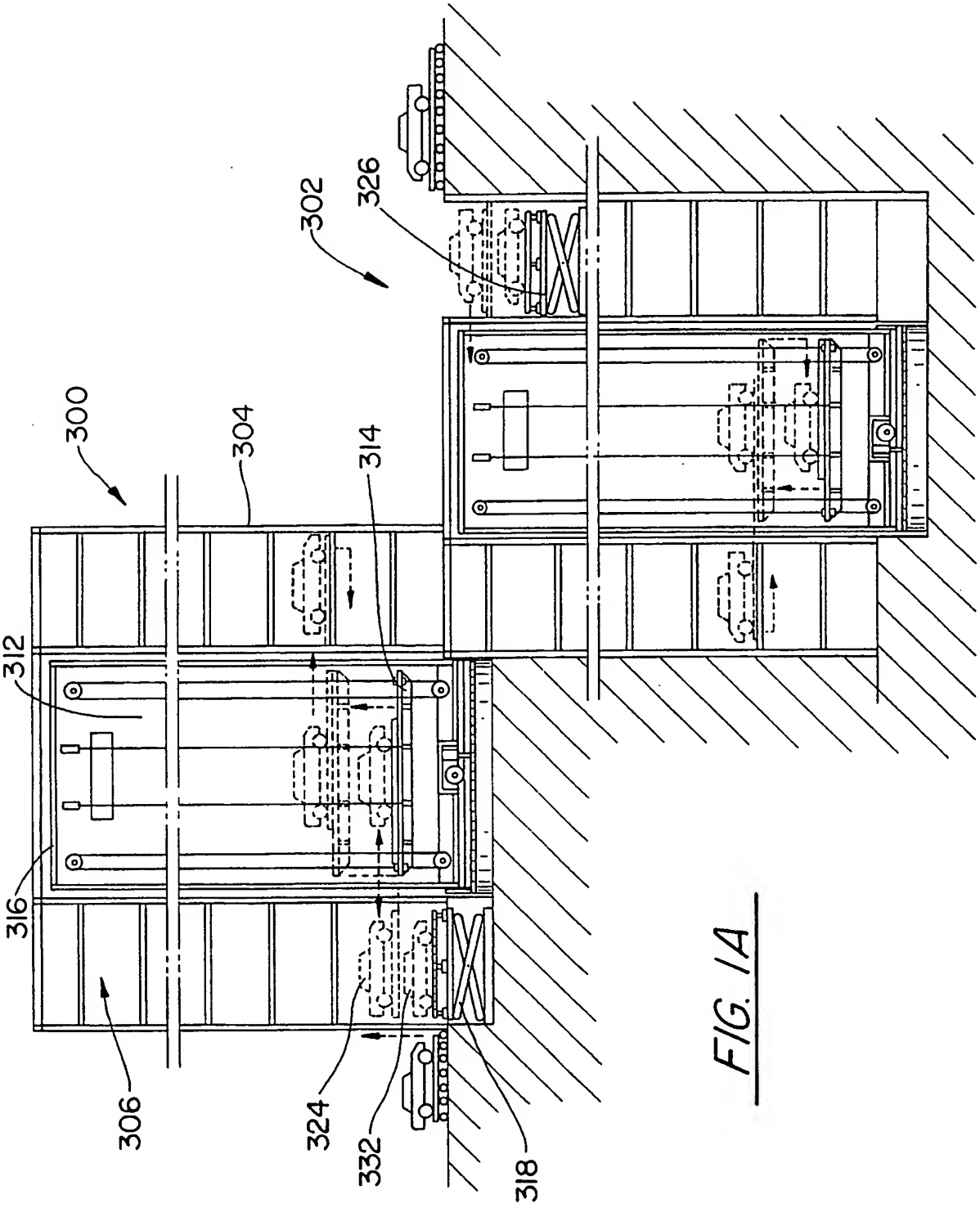


FIG. 1A

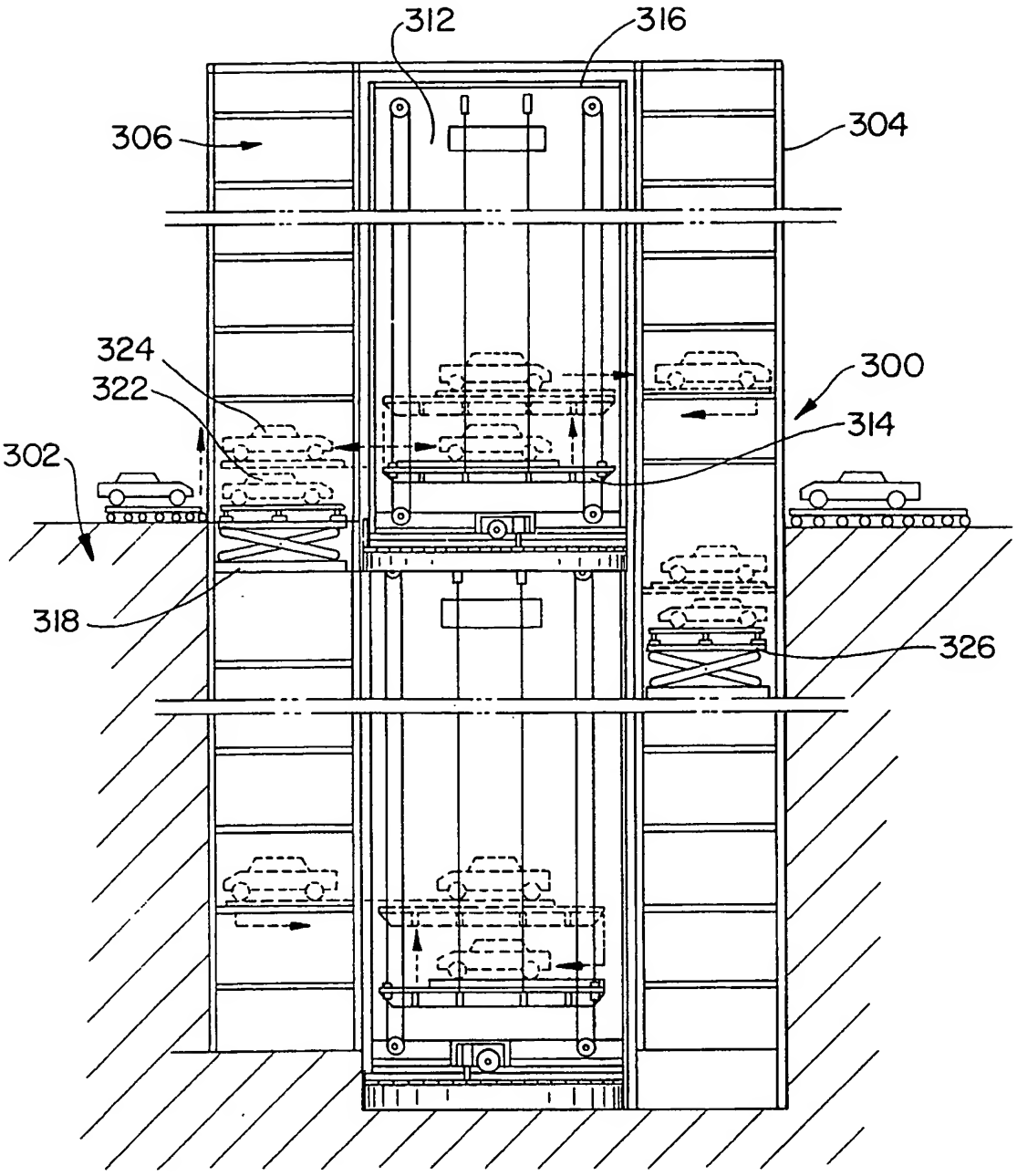


FIG. 1B

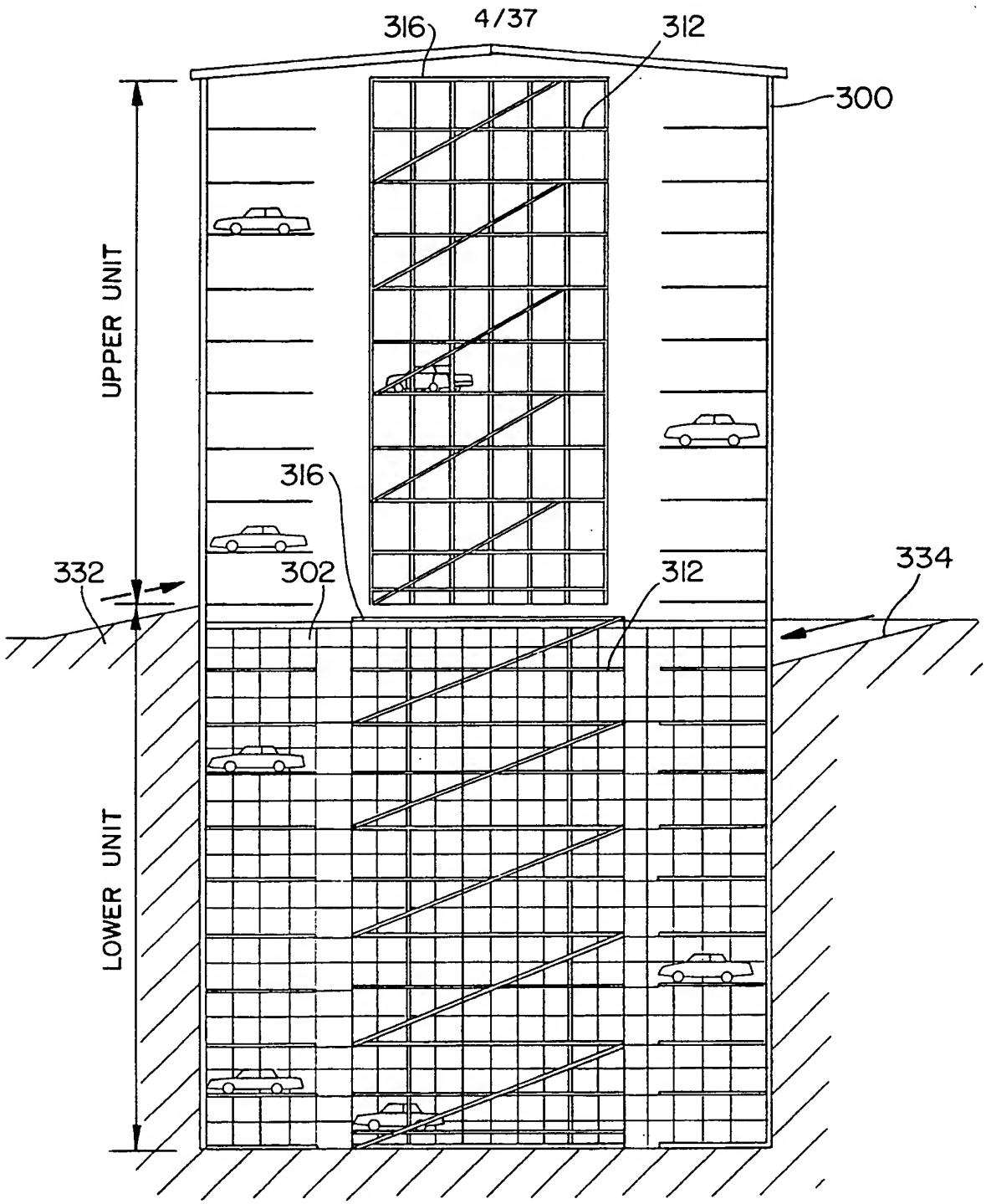


FIG. 1C

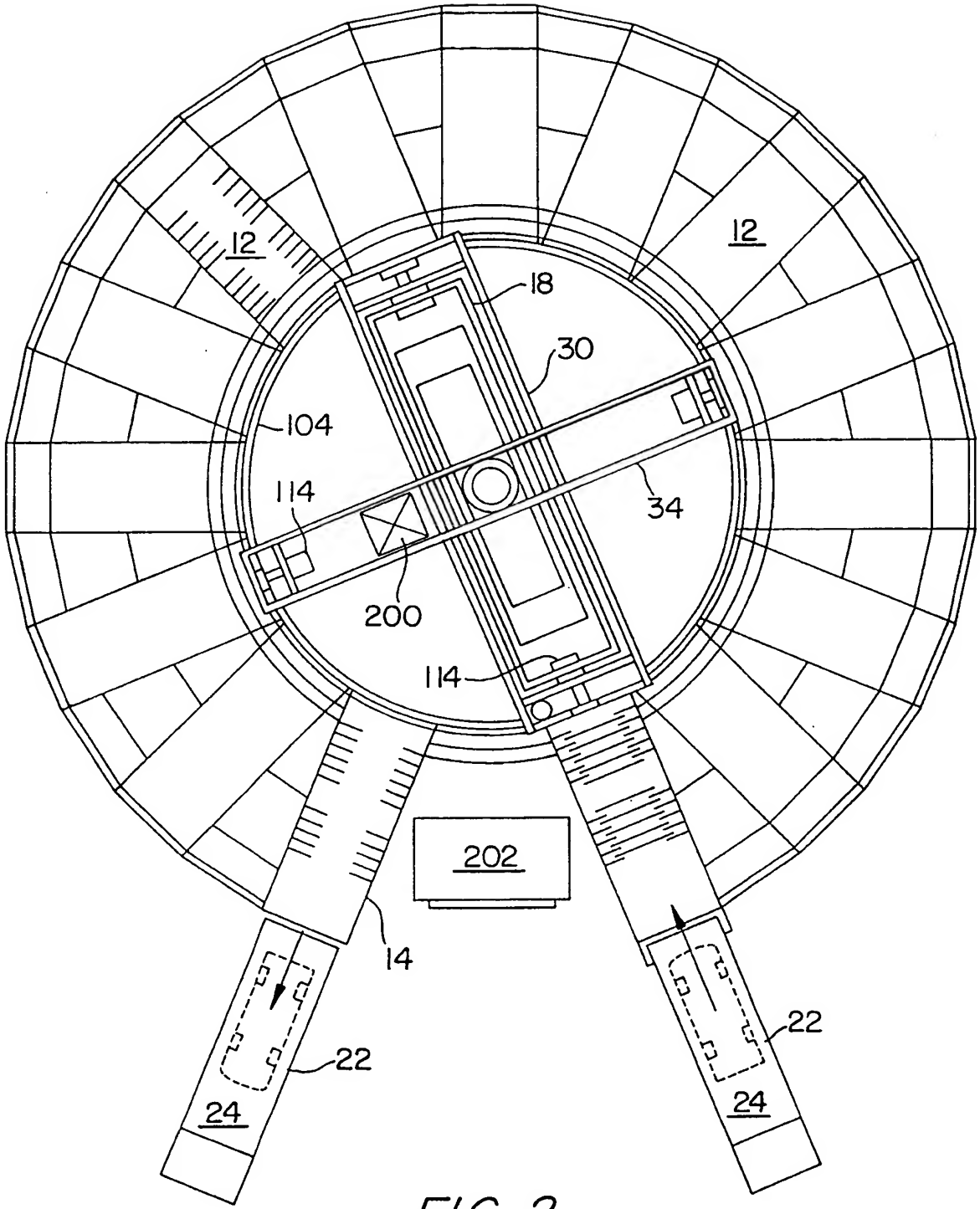


FIG. 2

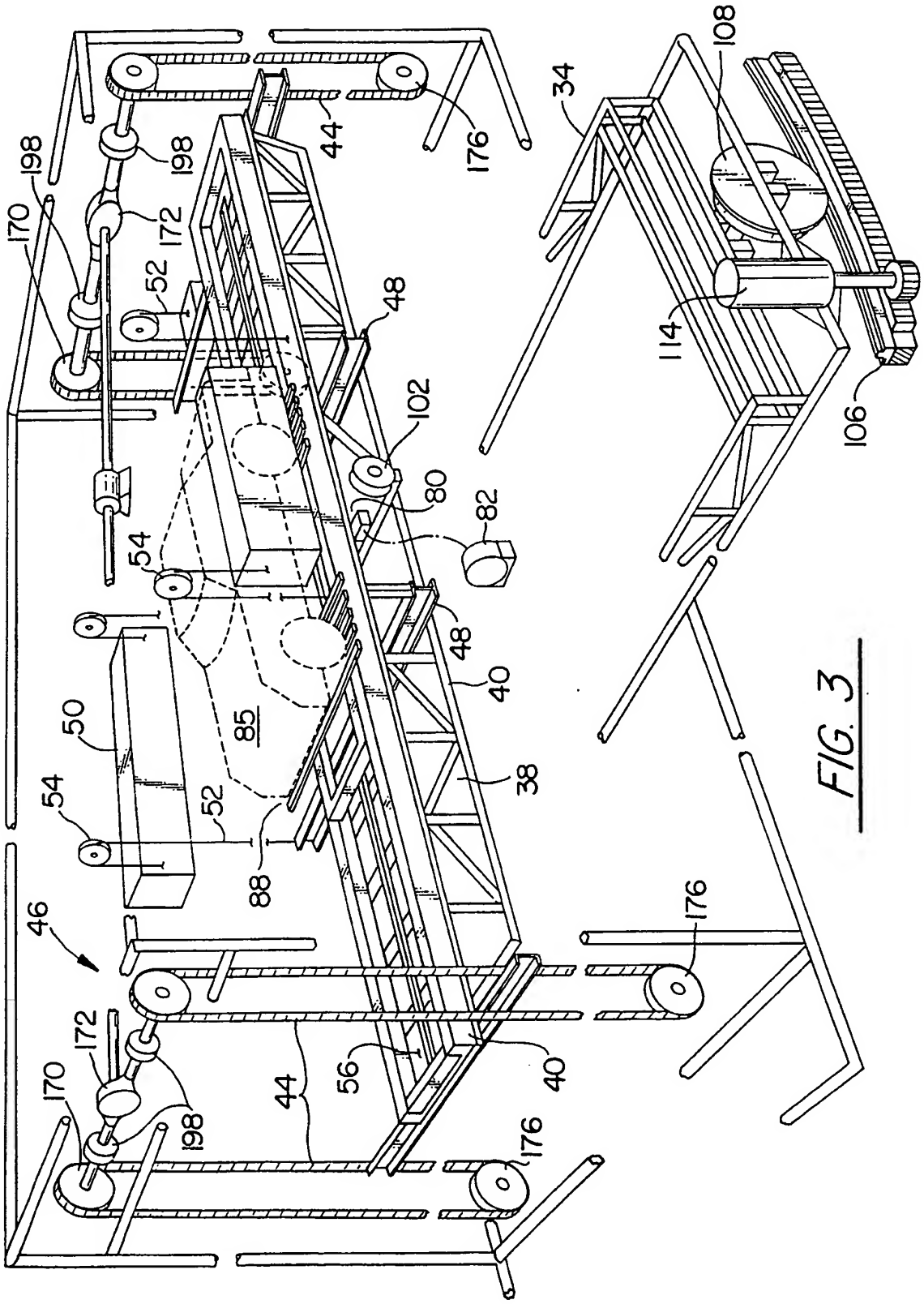

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FIG. 3

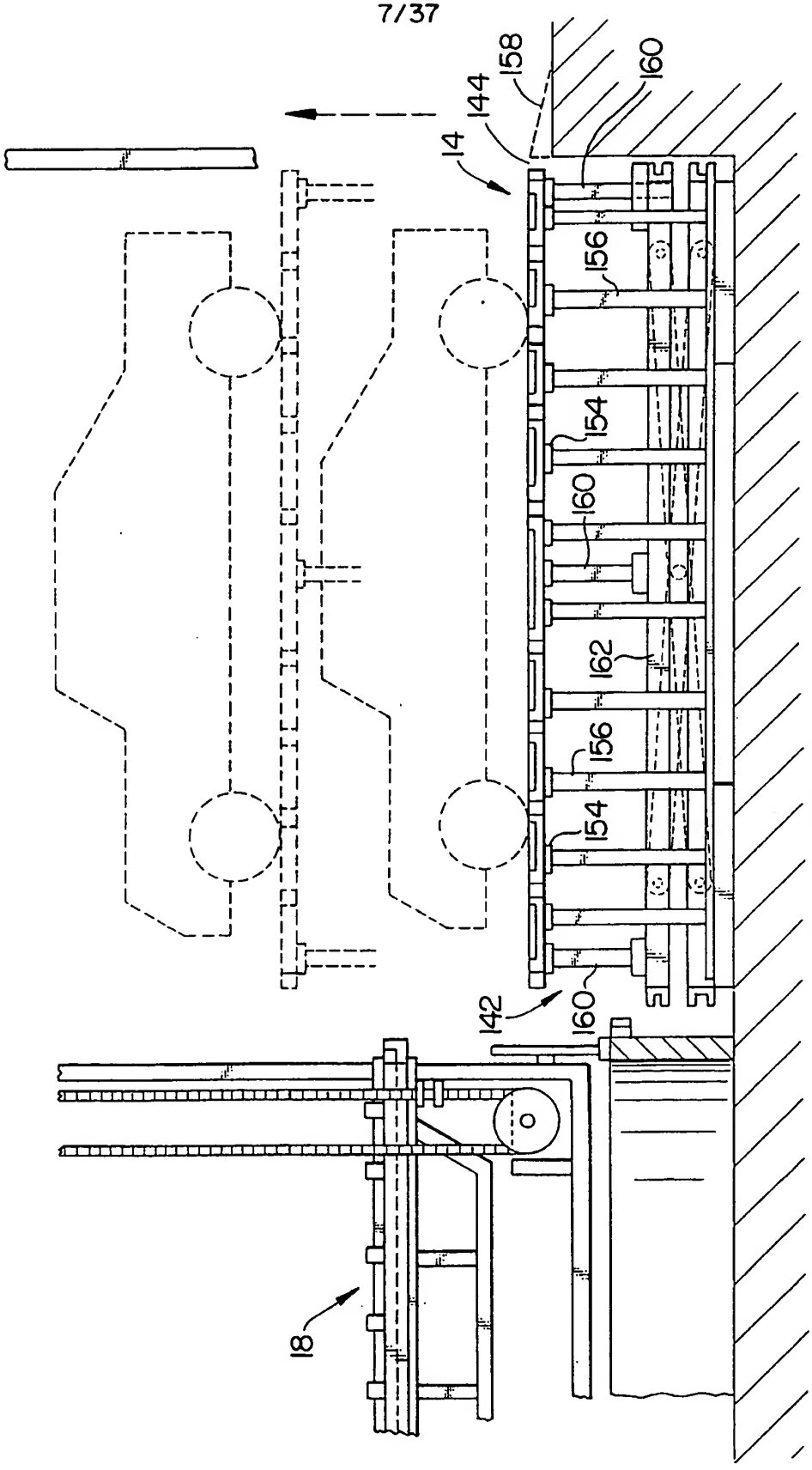

FIG. 4

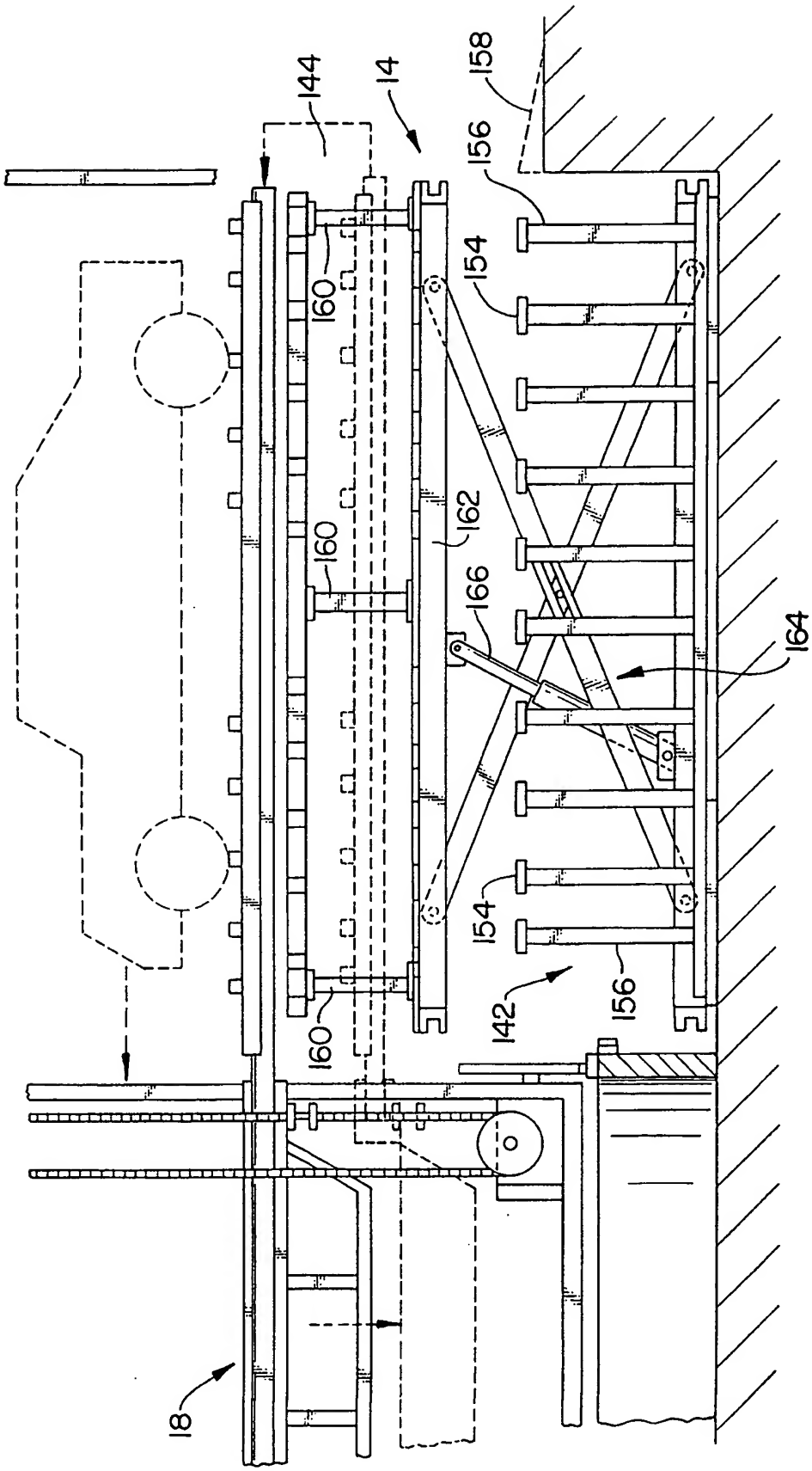

FIG. 5

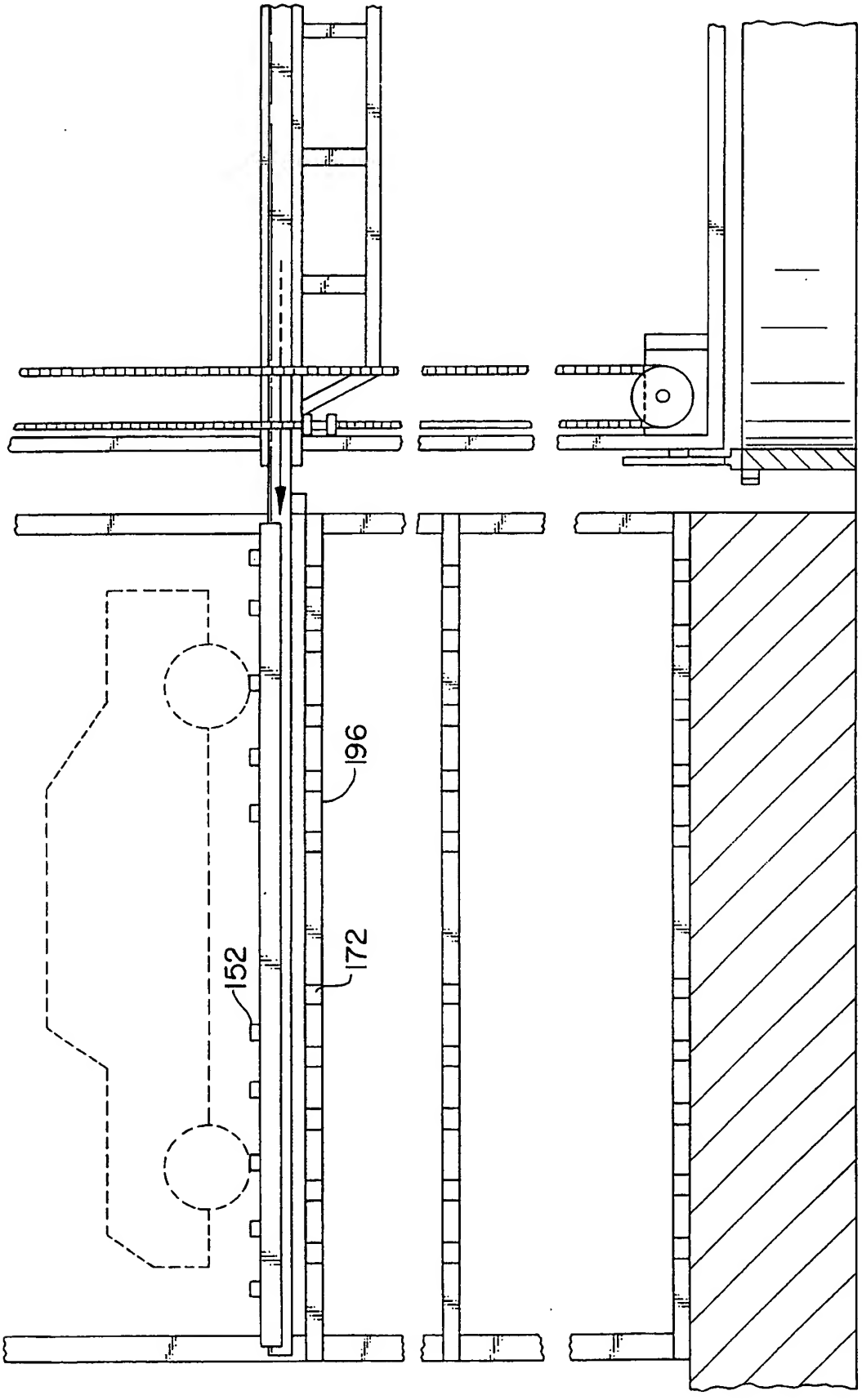

FIG. 6

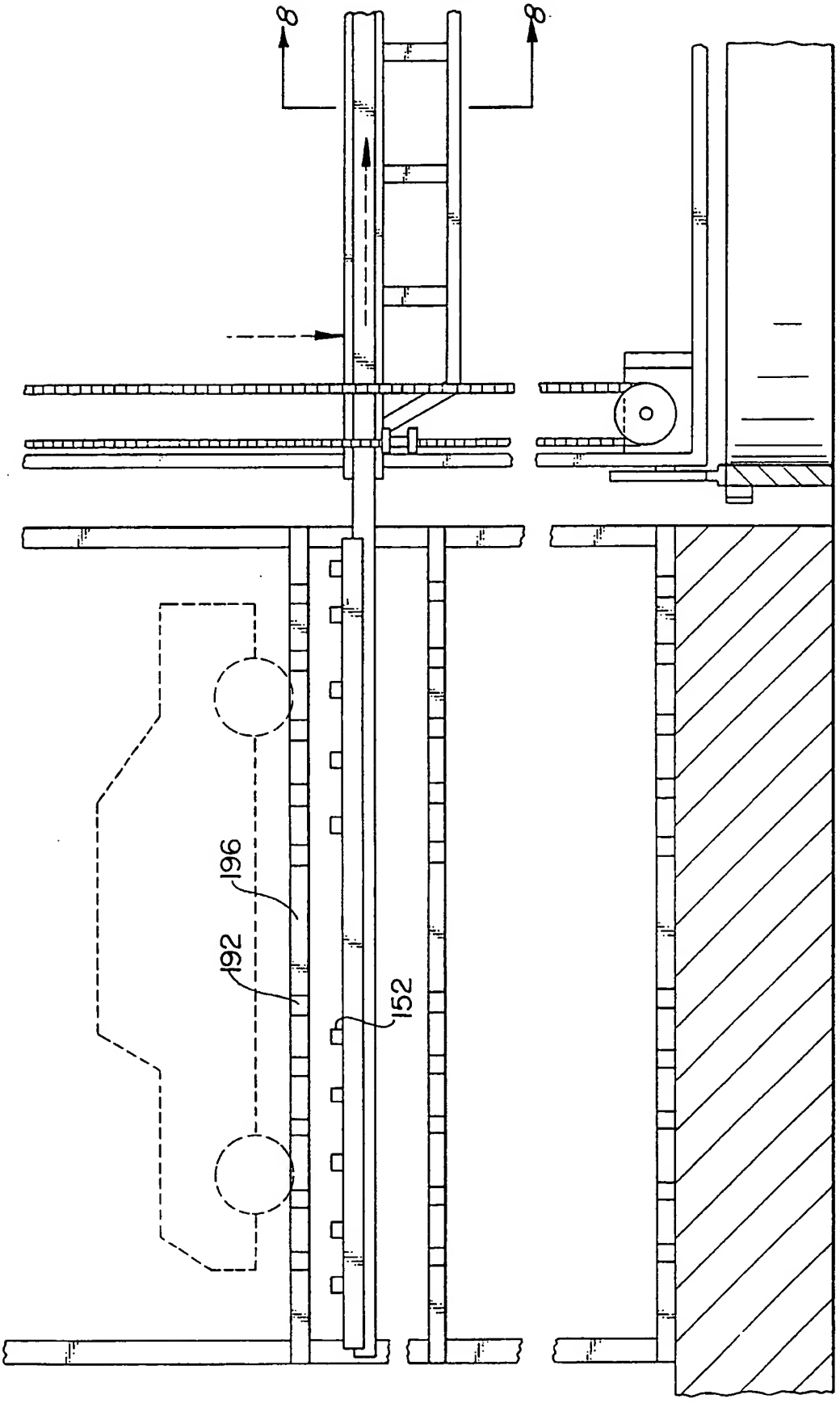

FIG. 7

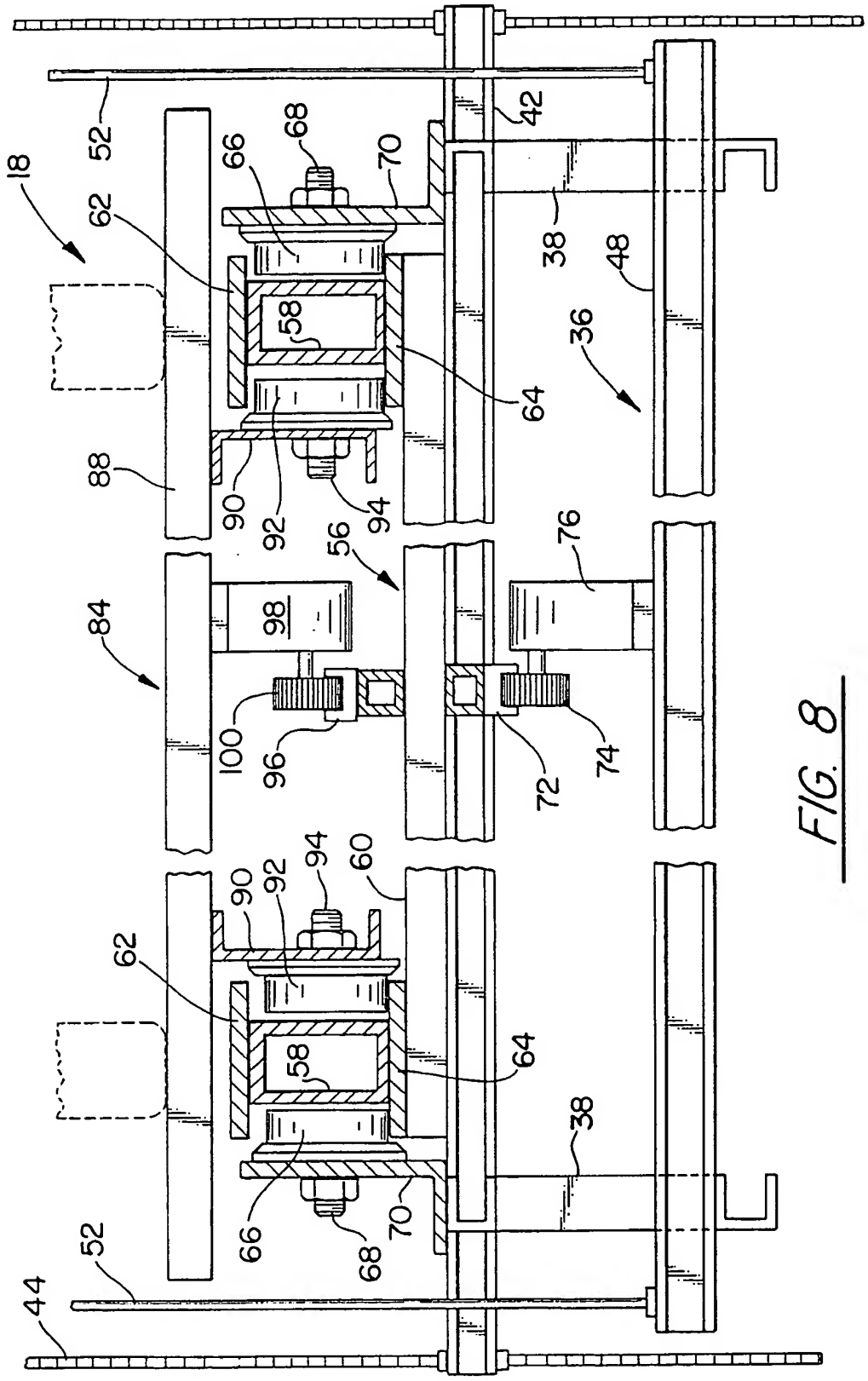
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FIG. 8

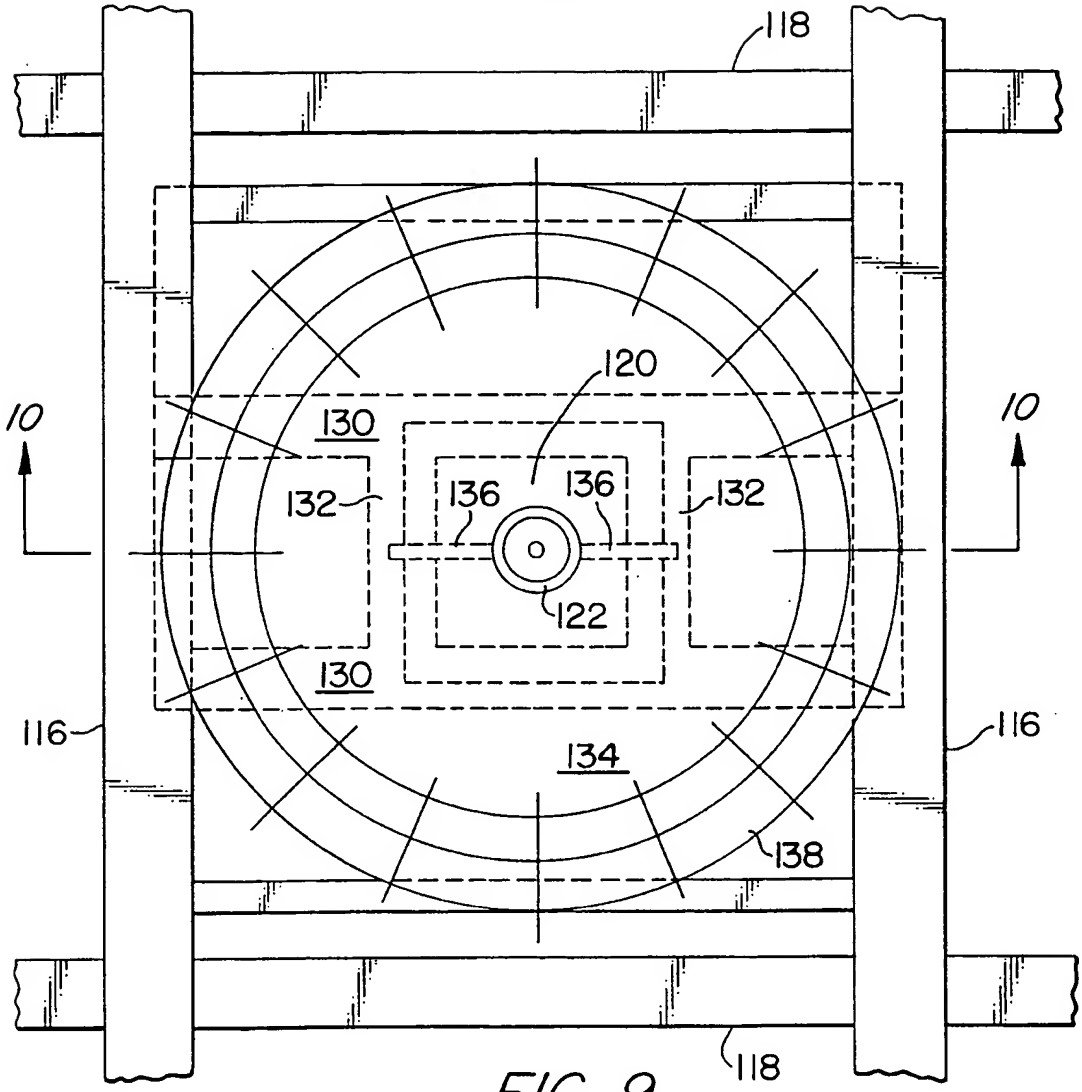
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FIG. 9

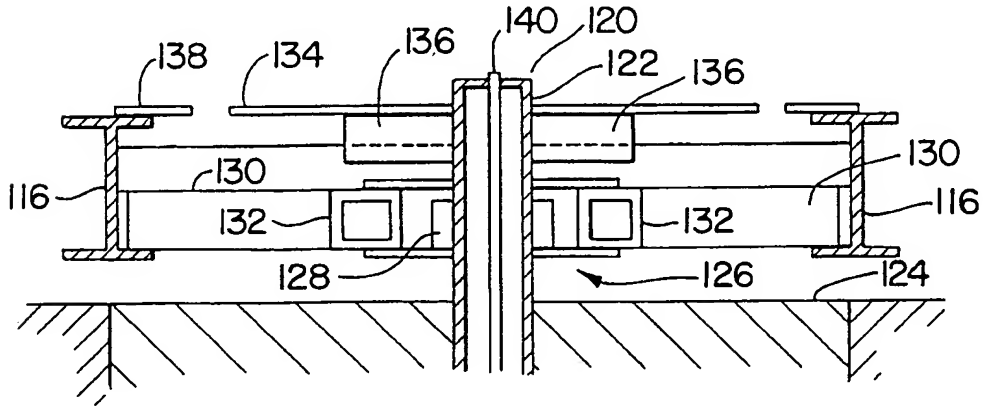
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FIG. 10

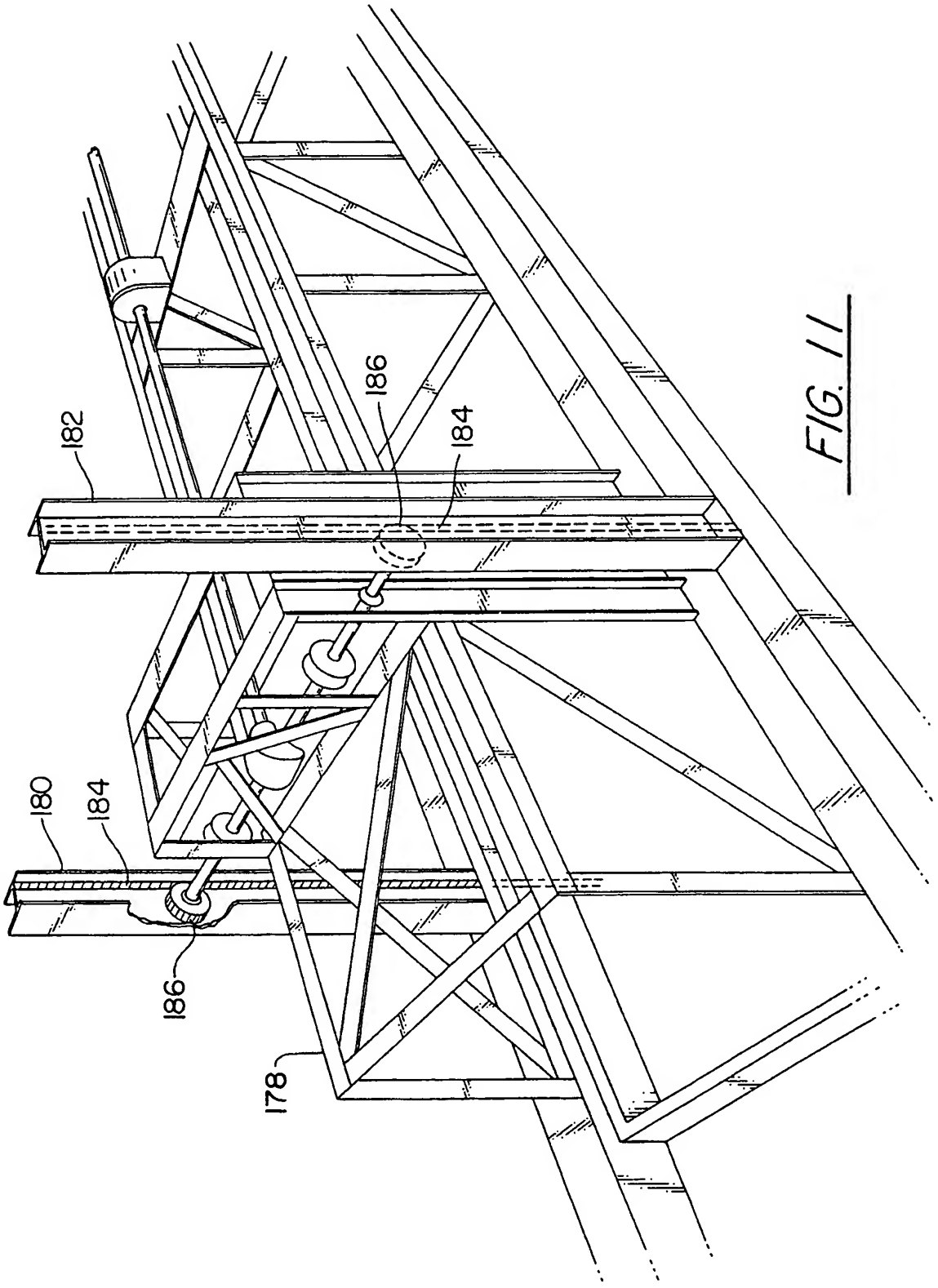

FIG. 11

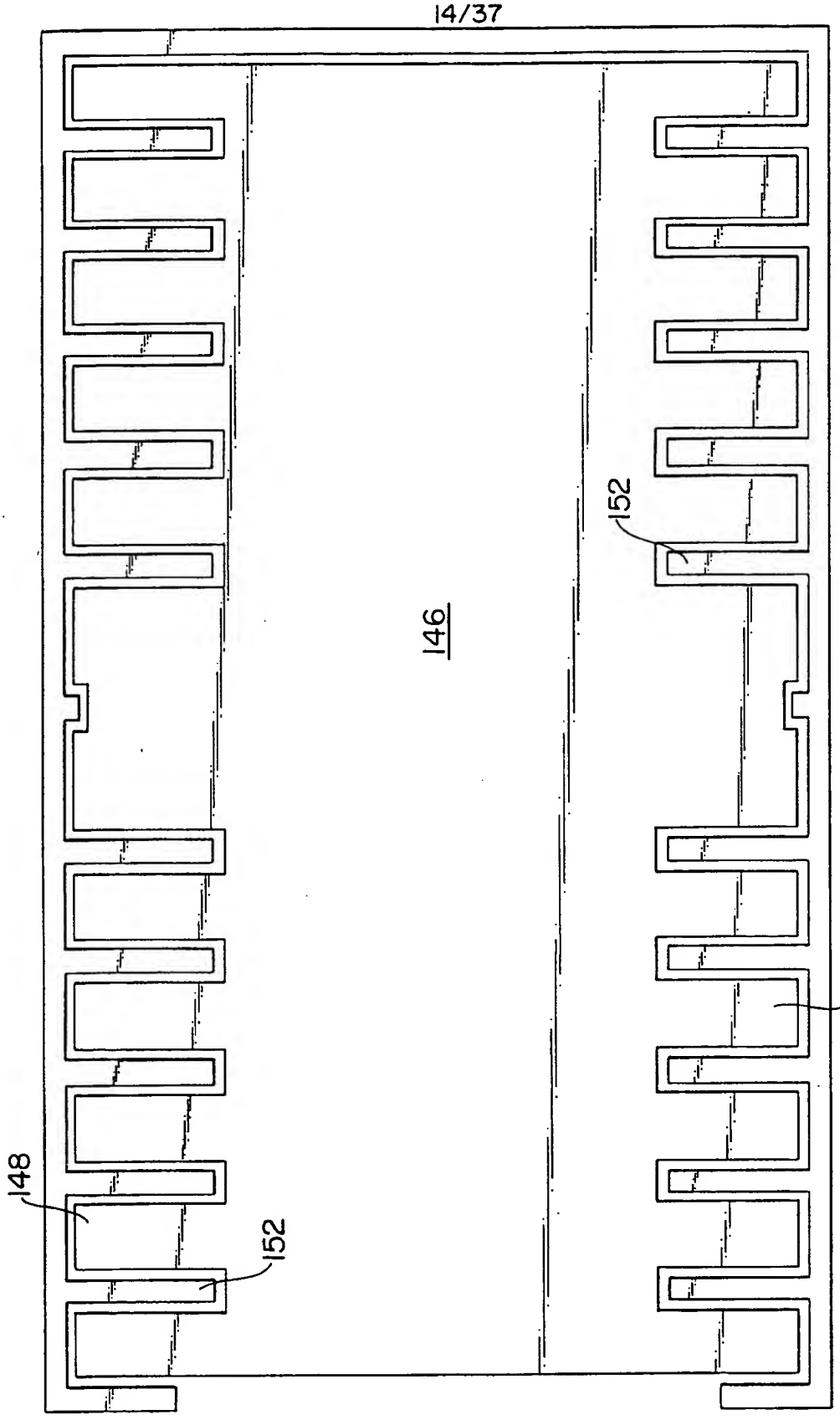

FIG. 12

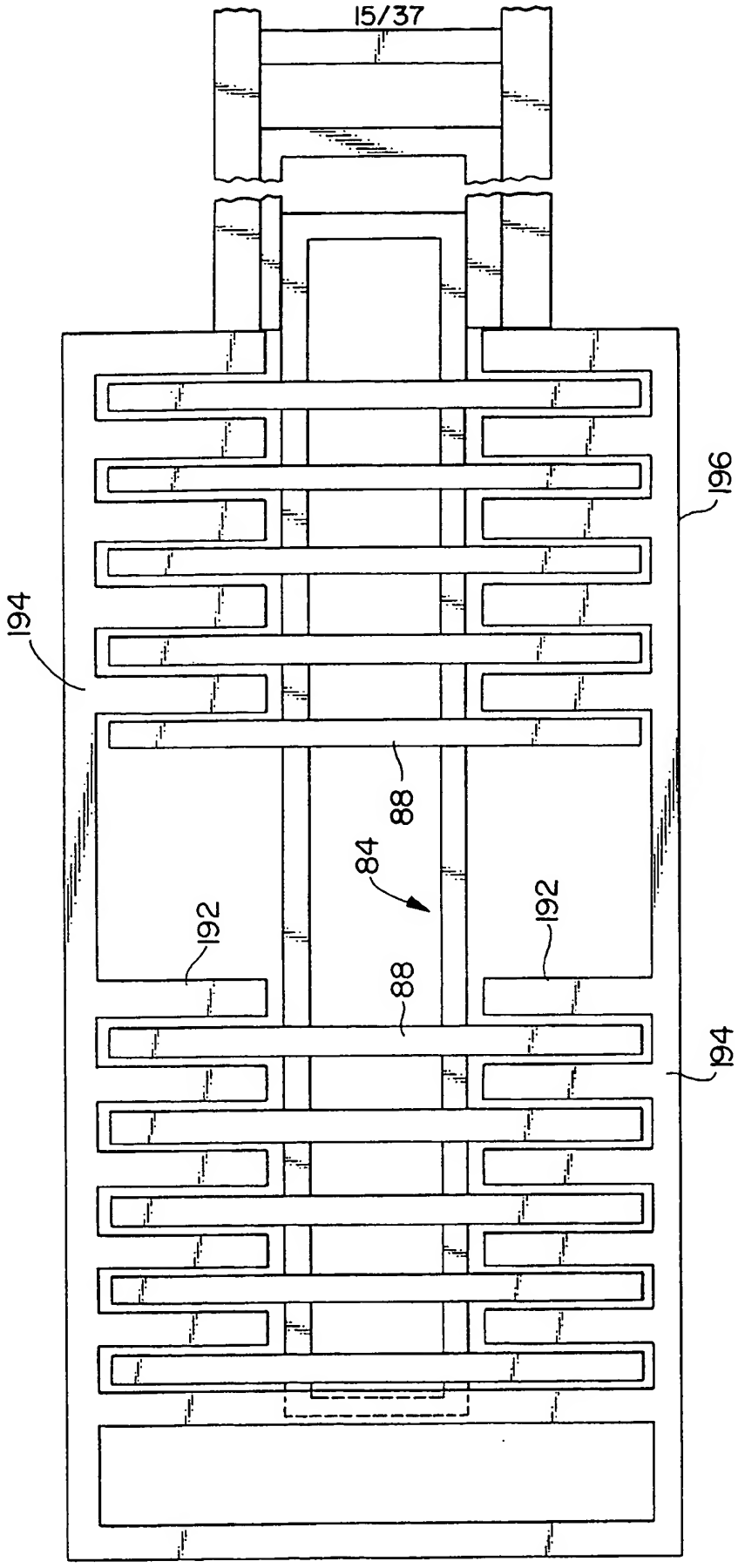

FIG. 13

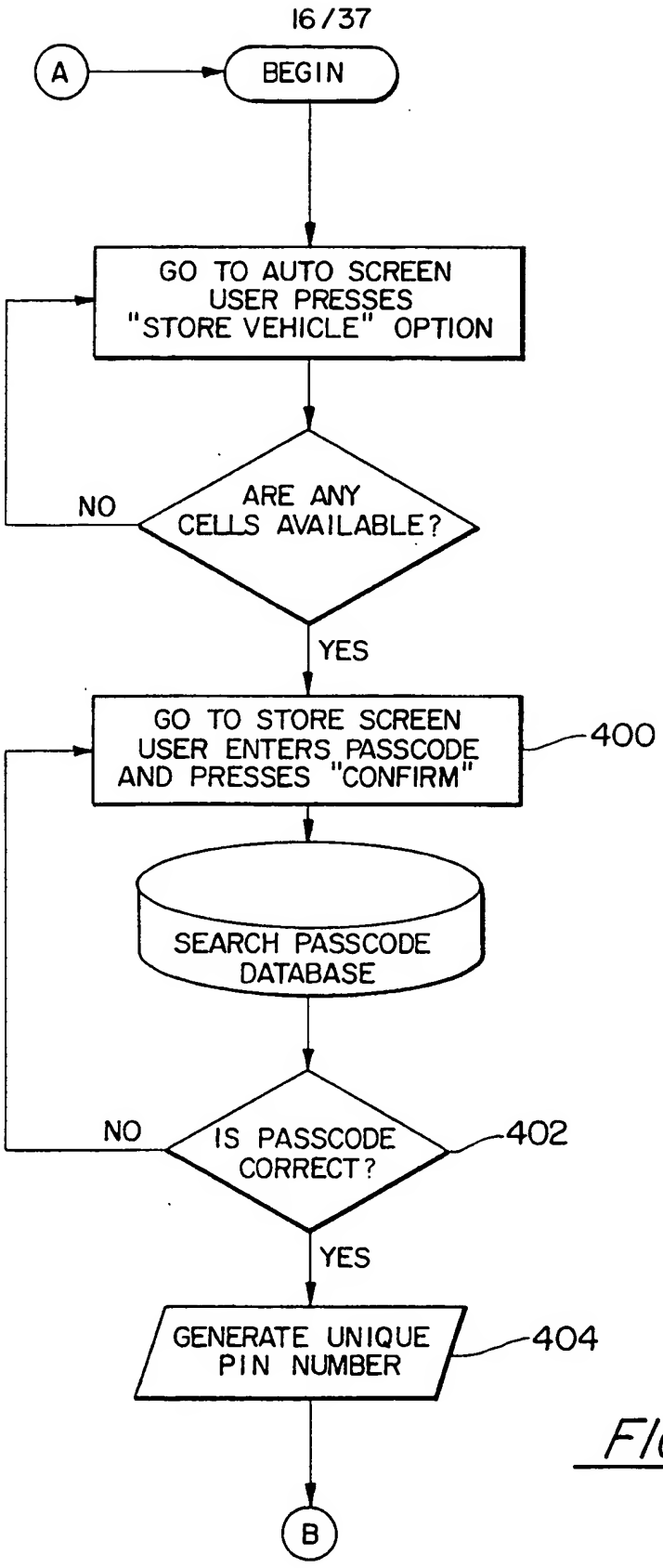
A
BEGIN
GO TO AUTO SCREEN
USER PRESSES
"STORE VEHICLE" OPTION
NO
ARE ANY
CELLS AVAILABLE?
YES
GO TO STORE SCREEN
USER ENTERS PASSCODE
AND PRESSES "CONFIRM"
400
SEARCH PASSCODE
DATABASE
NO
IS PASSCODE
CORRECT?
402
YES
GENERATE UNIQUE
PIN NUMBER
404
B

FIG. 14A

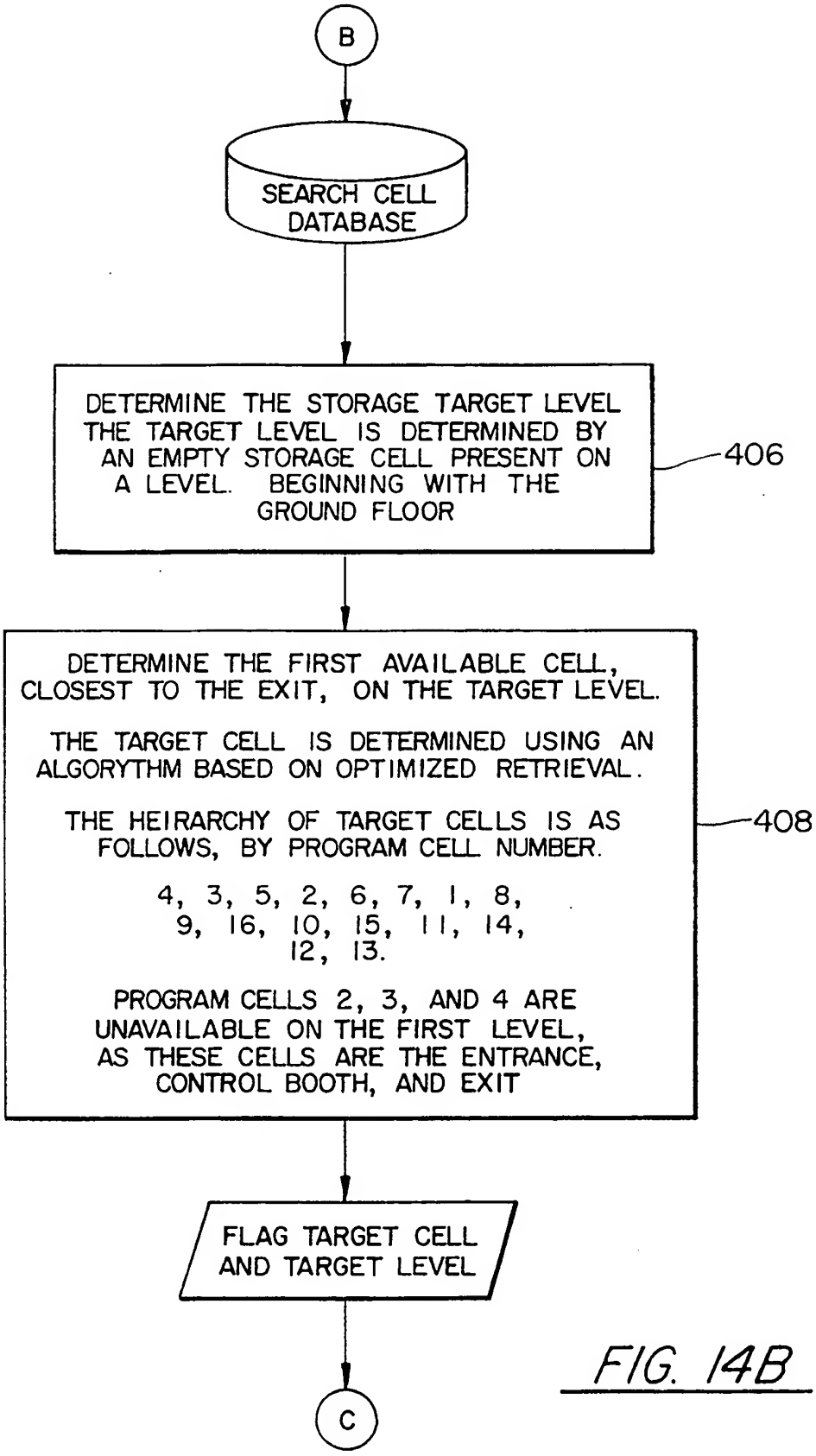
B
SEARCH CELL DATABASE
DETERMINE THE STORAGE TARGET LEVEL THE TARGET LEVEL IS DETERMINED BY AN EMPTY STORAGE CELL PRESENT ON A LEVEL. BEGINNING WITH THE GROUND FLOOR
406
DETERMINE THE FIRST AVAILABLE CELL, CLOSEST TO THE EXIT, ON THE TARGET LEVEL.
THE TARGET CELL IS DETERMINED USING AN ALGORYTHM BASED ON OPTIMIZED RETRIEVAL.
THE HEIRARCHY OF TARGET CELLS IS AS FOLLOWS, BY PROGRAM CELL NUMBER.
4, 3, 5, 2, 6, 7, 1, 8, 9, 16, 10, 15, 11, 14, 12, 13.
PROGRAM CELLS 2, 3, AND 4 ARE UNAVAILABLE ON THE FIRST LEVEL, AS THESE CELLS ARE THE ENTRANCE, CONTROL BOOTH, AND EXIT
408
FLAG TARGET CELL AND TARGET LEVEL
C

FIG. 14B

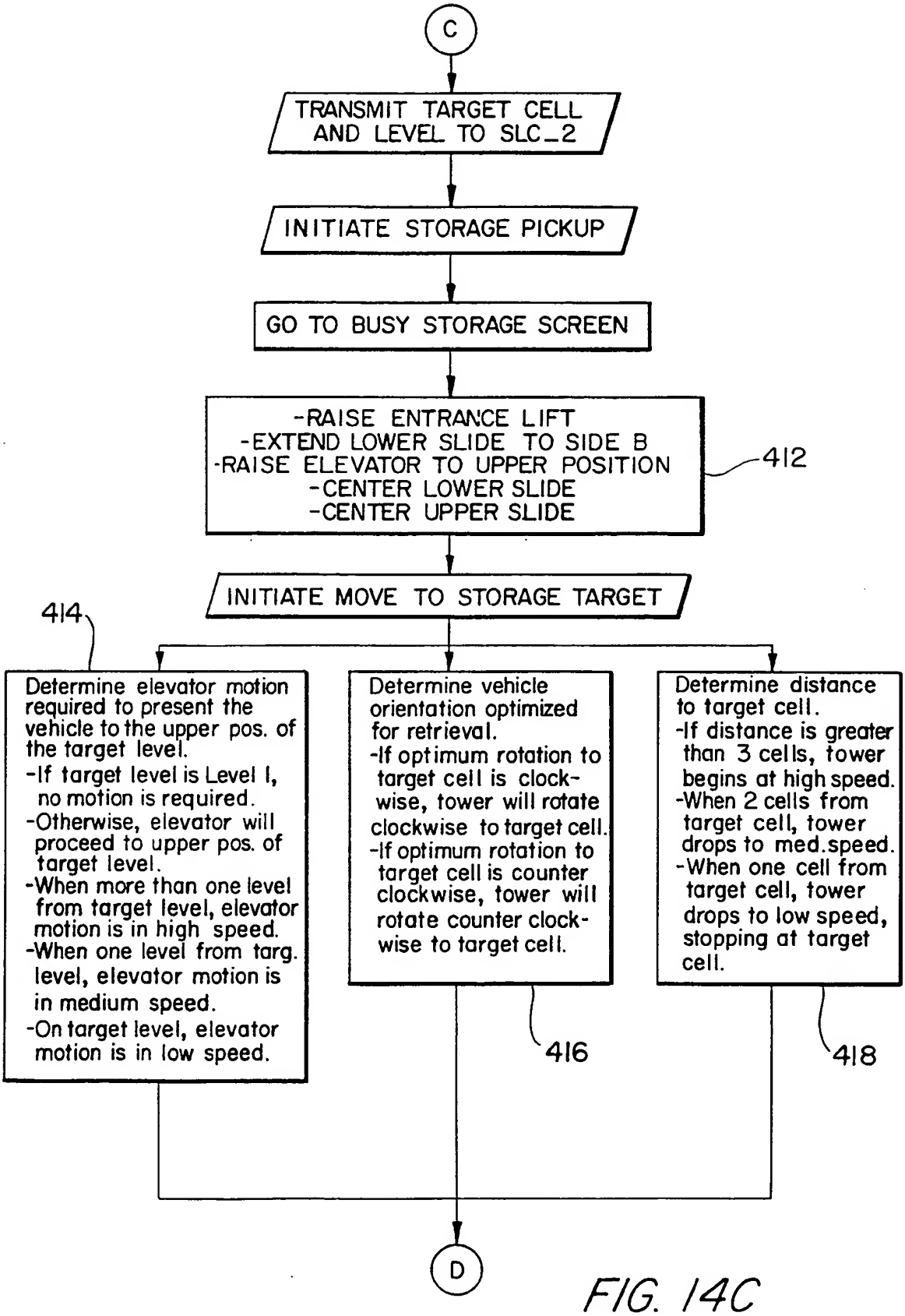
C
TRANSMIT TARGET CELL AND LEVEL TO SLC_2
INITIATE STORAGE PICKUP
GO TO BUSY STORAGE SCREEN
-RAISE ENTRANCE LIFT
-EXTEND LOWER SLIDE TO SIDE B
-RAISE ELEVATOR TO UPPER POSITION
-CENTER LOWER SLIDE
-CENTER UPPER SLIDE
412
INITIATE MOVE TO STORAGE TARGET
414
Determine elevator motion required to present the vehicle to the upper pos. of the target level.
-If target level is Level 1, no motion is required.
-Otherwise, elevator will proceed to upper pos. of target level.
-When more than one level from target level, elevator motion is in high speed.
-When one level from targ. level, elevator motion is in medium speed.
-On target level, elevator motion is in low speed.
Determine vehicle orientation optimized for retrieval.
-If optimum rotation to target cell is clock-wise, tower will rotate clockwise to target cell.
-If optimum rotation to target cell is counter clockwise, tower will rotate counter clock-wise to target cell.
416
Determine distance to target cell.
-If distance is greater than 3 cells, tower begins at high speed.
-When 2 cells from target cell, tower drops to med.speed.
-When one cell from target cell, tower drops to low speed, stopping at target cell.
418
D

FIG. 14C

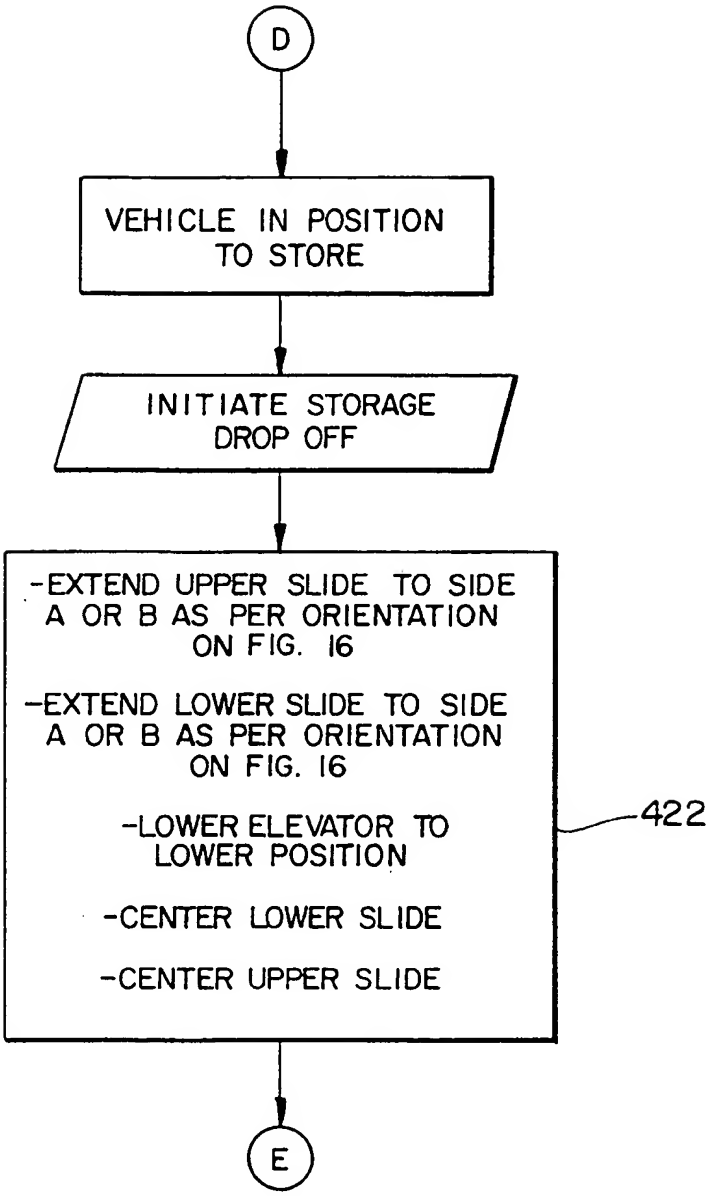
D
VEHICLE IN POSITION TO STORE
INITIATE STORAGE DROP OFF
-EXTEND UPPER SLIDE TO SIDE A OR B AS PER ORIENTATION ON FIG. 16
-EXTEND LOWER SLIDE TO SIDE A OR B AS PER ORIENTATION ON FIG. 16
-LOWER ELEVATOR TO LOWER POSITION
-CENTER LOWER SLIDE
-CENTER UPPER SLIDE
422
E

FIG. 14D

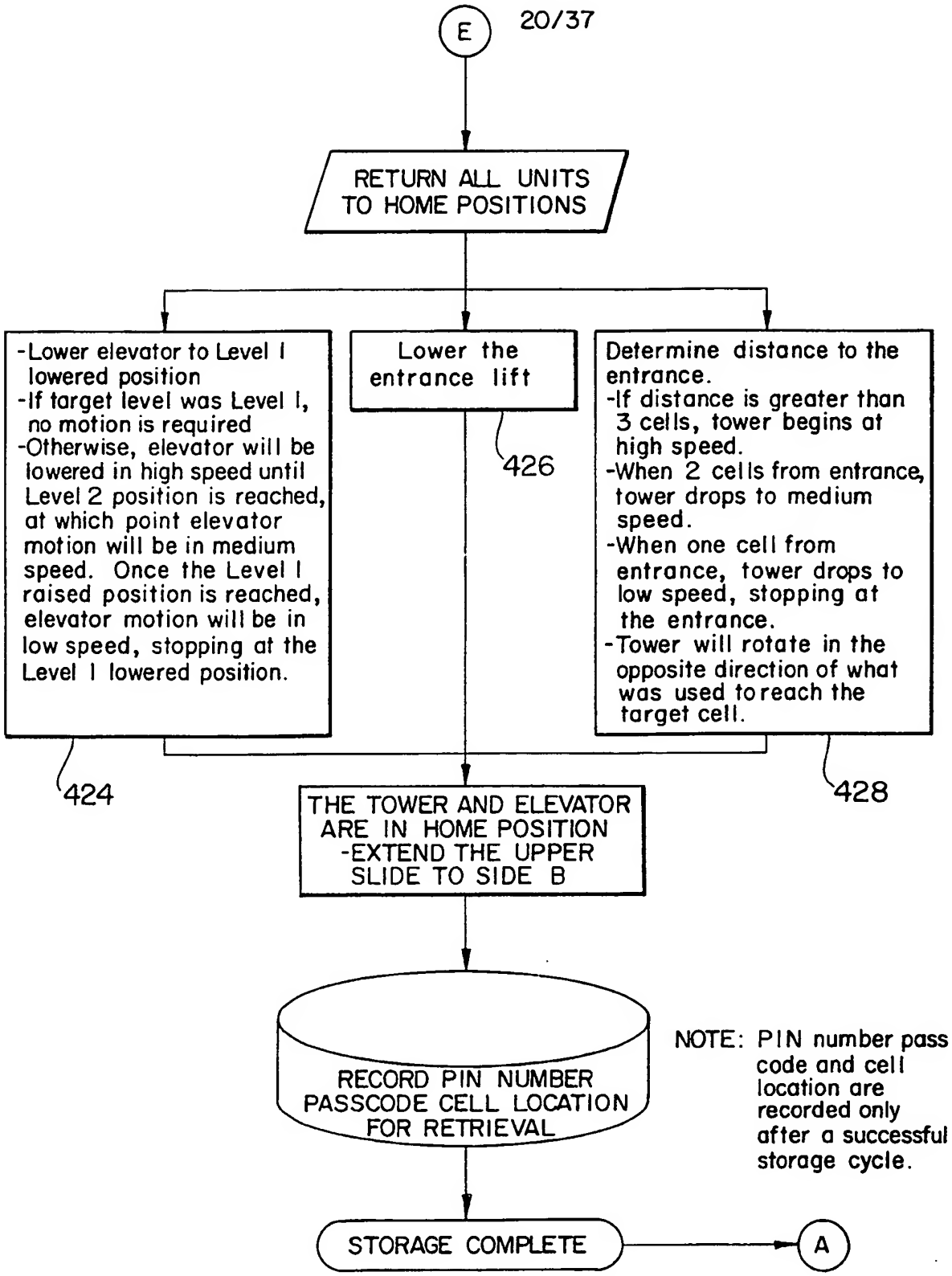
E
20/37
RETURN ALL UNITS TO HOME POSITIONS
-Lower elevator to Level I lowered position
-If target level was Level I, no motion is required
-Otherwise, elevator will be lowered in high speed until Level 2 position is reached, at which point elevator motion will be in medium speed. Once the Level I raised position is reached, elevator motion will be in low speed, stopping at the Level I lowered position.
Lower the entrance lift
426
Determine distance to the entrance.
-If distance is greater than 3 cells, tower begins at high speed.
-When 2 cells from entrance, tower drops to medium speed.
-When one cell from entrance, tower drops to low speed, stopping at the entrance.
-Tower will rotate in the opposite direction of what was used to reach the target cell.
424
428
THE TOWER AND ELEVATOR ARE IN HOME POSITION -EXTEND THE UPPER SLIDE TO SIDE B
RECORD PIN NUMBER PASSCODE CELL LOCATION FOR RETRIEVAL
NOTE: PIN number pass code and cell location are recorded only after a successful storage cycle.
STORAGE COMPLETE
A

FIG. 14E

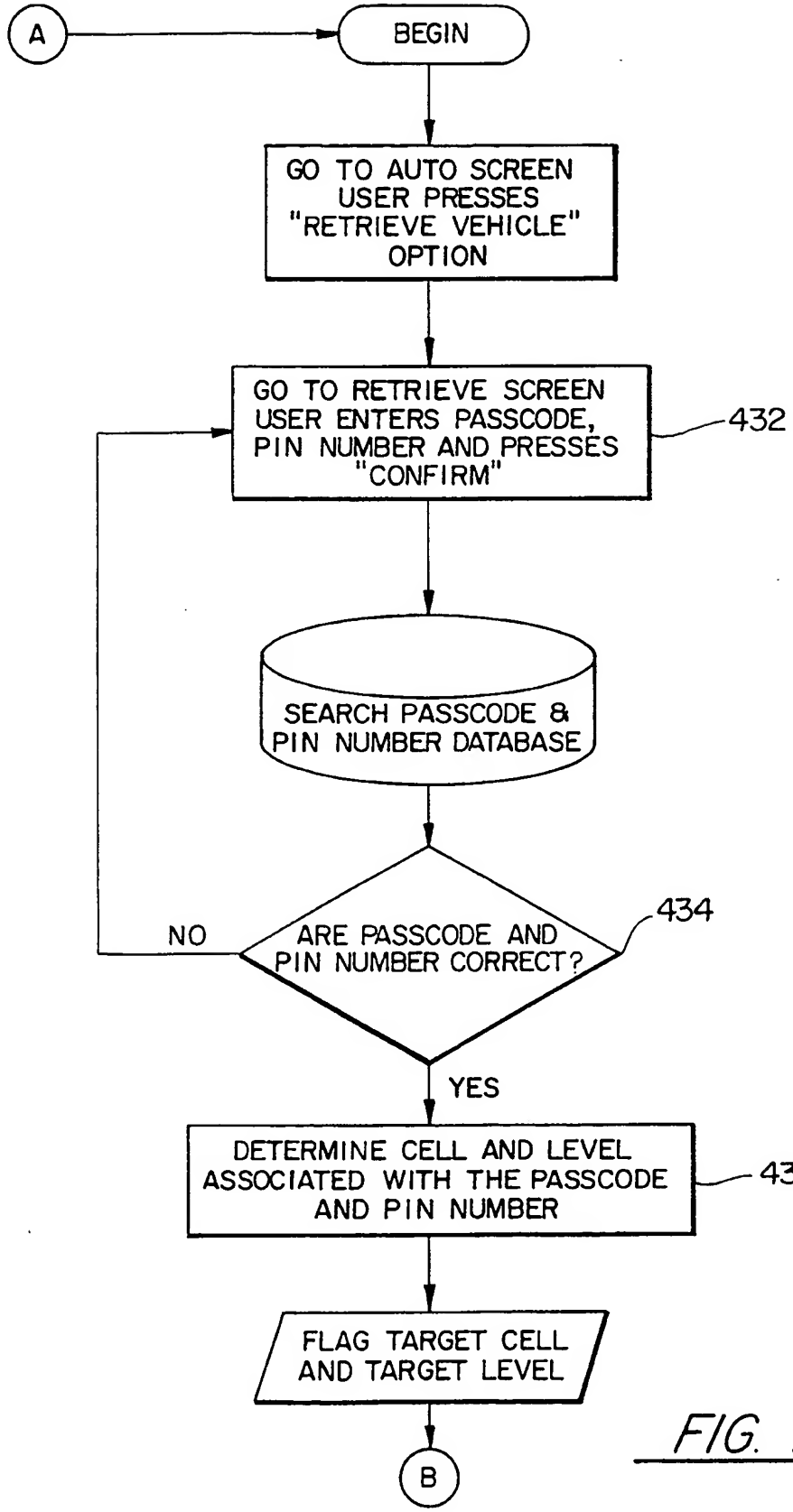
A
BEGIN
GO TO AUTO SCREEN
USER PRESSES
"RETRIEVE VEHICLE"
OPTION
GO TO RETRIEVE SCREEN
USER ENTERS PASSCODE,
PIN NUMBER AND PRESSES
"CONFIRM"
432
SEARCH PASSCODE &
PIN NUMBER DATABASE
NO
ARE PASSCODE AND
PIN NUMBER CORRECT?
434
YES
DETERMINE CELL AND LEVEL
ASSOCIATED WITH THE PASSCODE
AND PIN NUMBER
436
FLAG TARGET CELL
AND TARGET LEVEL
B

FIG. 15A

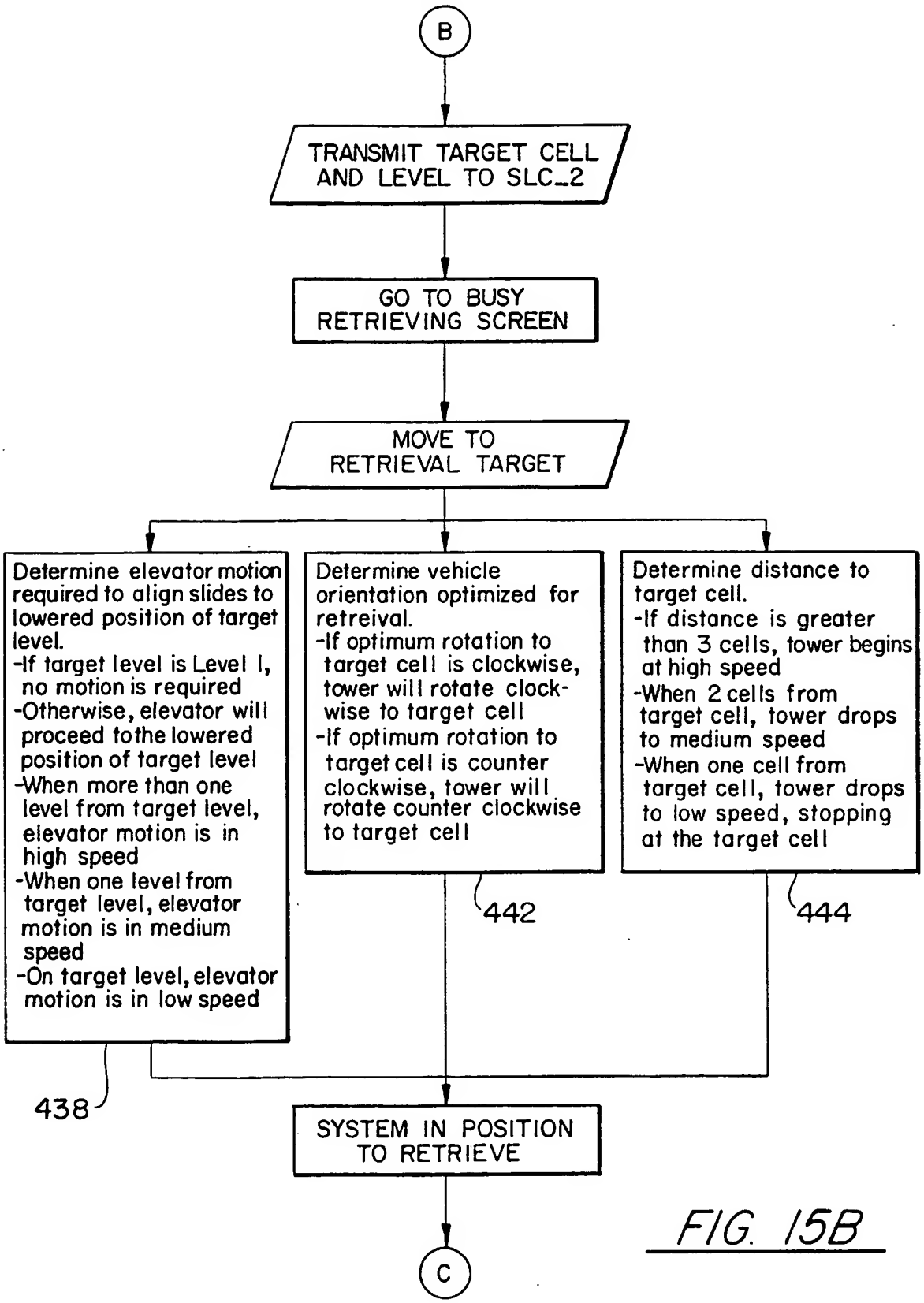
B
TRANSMIT TARGET CELL AND LEVEL TO SLC_2
GO TO BUSY RETRIEVING SCREEN
MOVE TO RETRIEVAL TARGET
Determine elevator motion required to align slides to lowered position of target level.
-If target level is Level 1, no motion is required
-Otherwise, elevator will proceed to the lowered position of target level
-When more than one level from target level, elevator motion is in high speed
-When one level from target level, elevator motion is in medium speed
-On target level, elevator motion is in low speed
438
Determine vehicle orientation optimized for retreival.
-If optimum rotation to target cell is clockwise, tower will rotate clockwise to target cell
-If optimum rotation to target cell is counter clockwise, tower will rotate counter clockwise to target cell
442
Determine distance to target cell.
-If distance is greater than 3 cells, tower begins at high speed
-When 2 cells from target cell, tower drops to medium speed
-When one cell from target cell, tower drops to low speed, stopping at the target cell
444
SYSTEM IN POSITION TO RETRIEVE
C

FIG. 15B

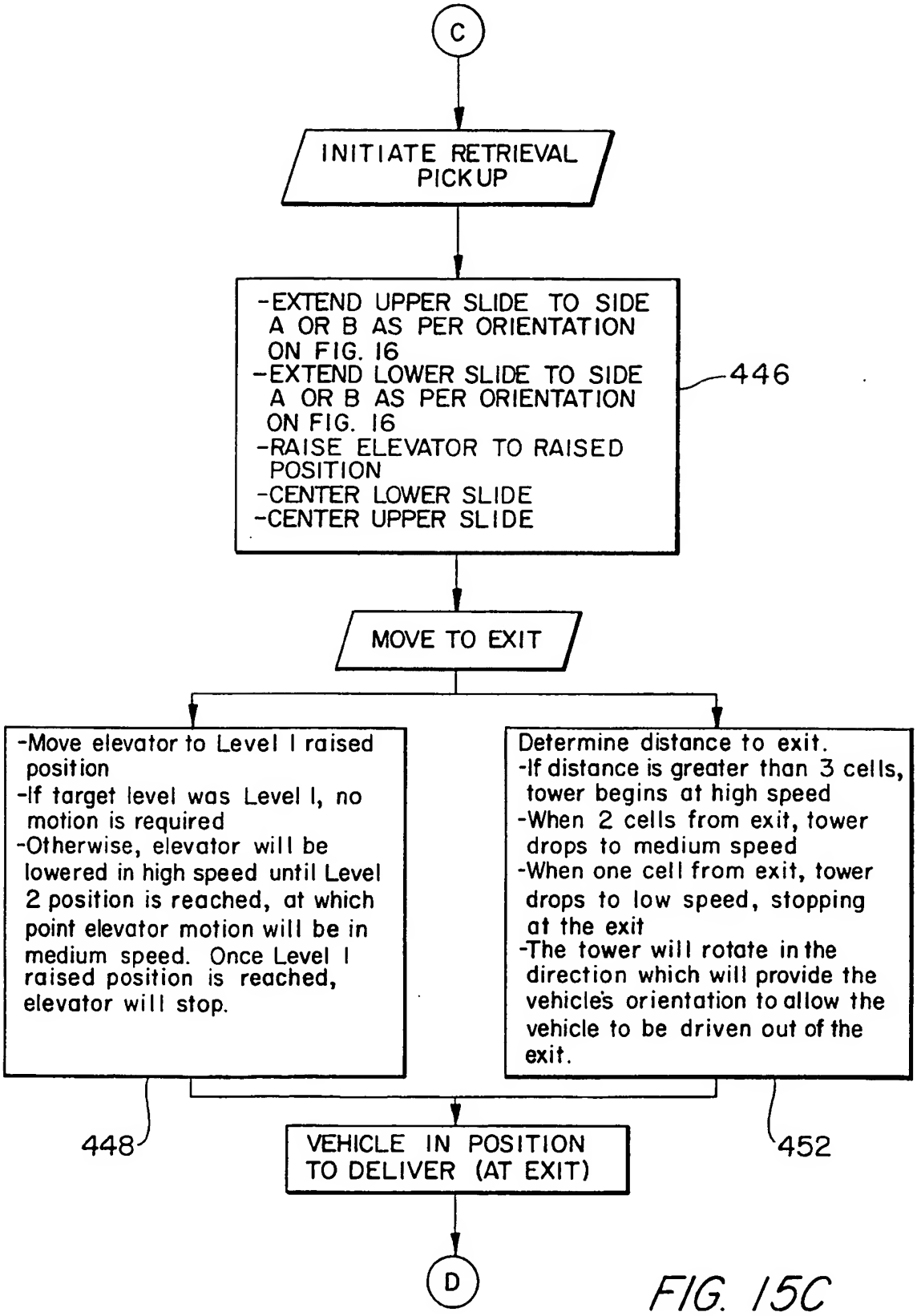
C
INITIATE RETRIEVAL PICKUP
-EXTEND UPPER SLIDE TO SIDE A OR B AS PER ORIENTATION ON FIG. 16
-EXTEND LOWER SLIDE TO SIDE A OR B AS PER ORIENTATION ON FIG. 16
-RAISE ELEVATOR TO RAISED POSITION
-CENTER LOWER SLIDE
-CENTER UPPER SLIDE
446
MOVE TO EXIT
-Move elevator to Level I raised position
-If target level was Level I, no motion is required
-Otherwise, elevator will be lowered in high speed until Level 2 position is reached, at which point elevator motion will be in medium speed. Once Level I raised position is reached, elevator will stop.
Determine distance to exit.
-If distance is greater than 3 cells, tower begins at high speed
-When 2 cells from exit, tower drops to medium speed
-When one cell from exit, tower drops to low speed, stopping at the exit
-The tower will rotate in the direction which will provide the vehicle's orientation to allow the vehicle to be driven out of the exit.
448
452
VEHICLE IN POSITION TO DELIVER (AT EXIT)
D

FIG. 15C

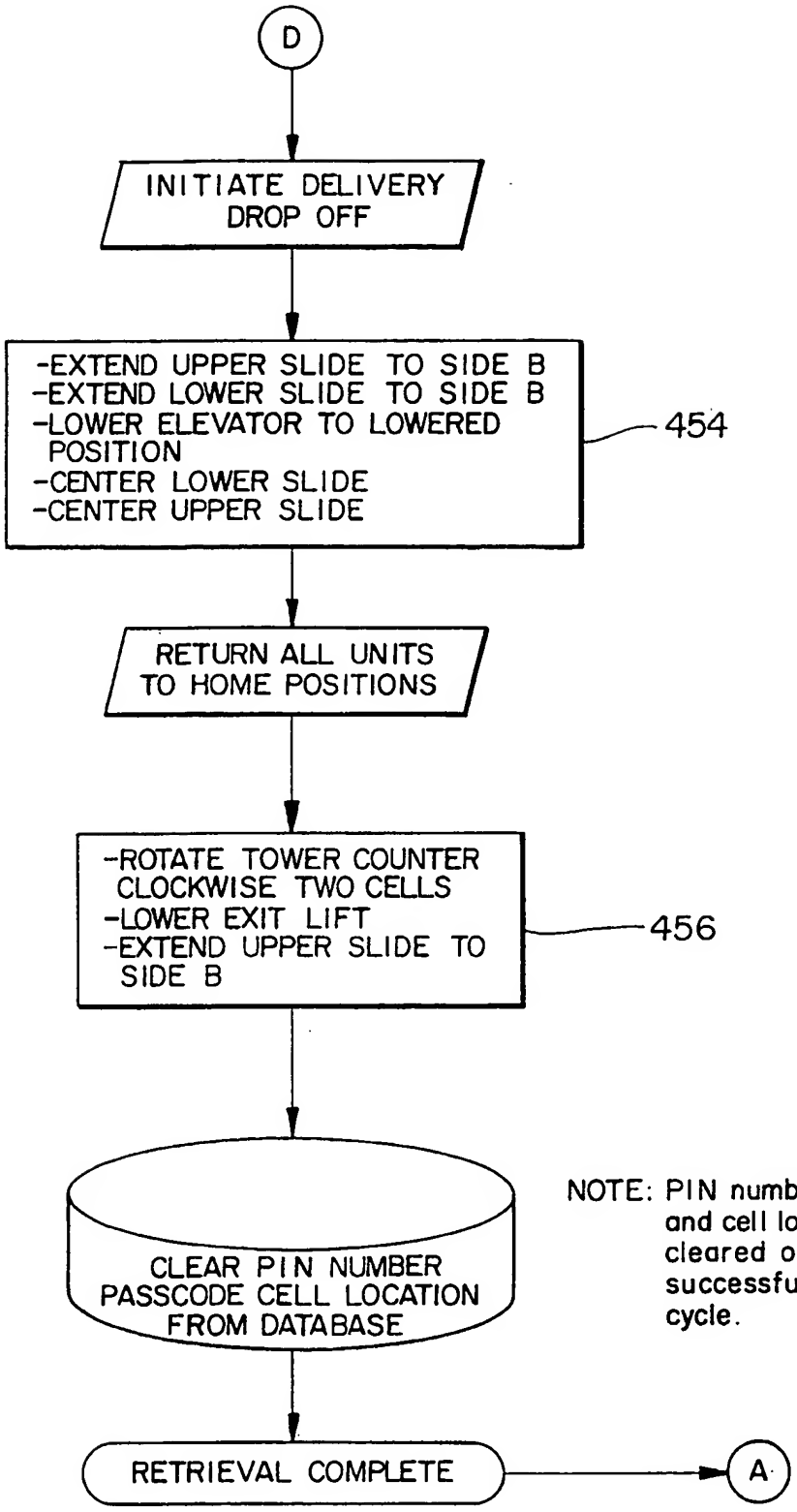
D
INITIATE DELIVERY DROP OFF
-EXTEND UPPER SLIDE TO SIDE B
-EXTEND LOWER SLIDE TO SIDE B
-LOWER ELEVATOR TO LOWERED POSITION
-CENTER LOWER SLIDE
-CENTER UPPER SLIDE
454
RETURN ALL UNITS TO HOME POSITIONS
-ROTATE TOWER COUNTER CLOCKWISE TWO CELLS
-LOWER EXIT LIFT
-EXTEND UPPER SLIDE TO SIDE B
456
CLEAR PIN NUMBER PASSCODE CELL LOCATION FROM DATABASE
NOTE: PIN number, passcode and cell location are cleared only after a successful retrieval cycle.
RETRIEVAL COMPLETE
A

FIG. 15D

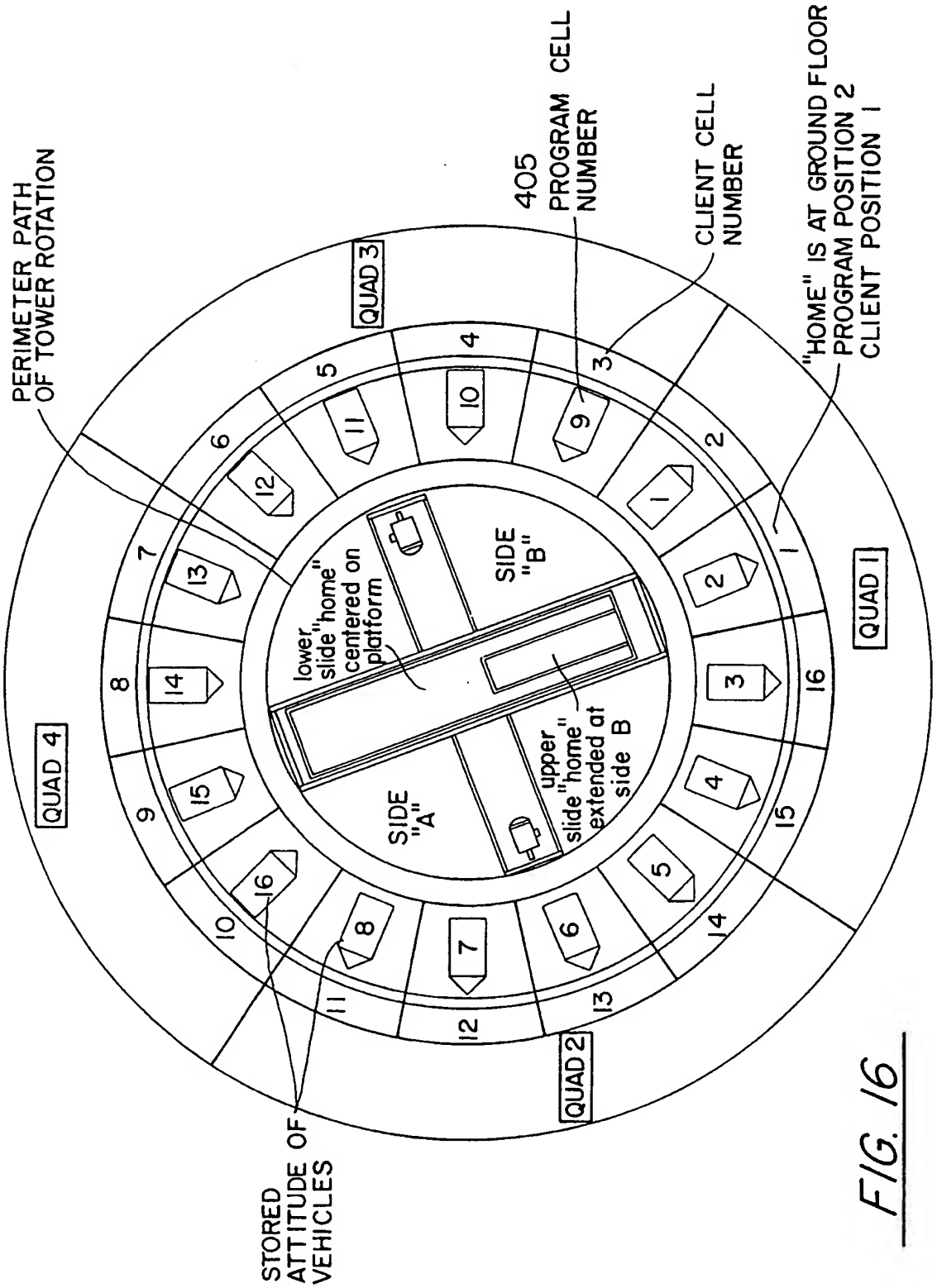
PERIMETER PATH OF TOWER ROTATION
405 PROGRAM CELL NUMBER
CLIENT CELL NUMBER
"HOME" IS AT GROUND FLOOR PROGRAM POSITION 2 CLIENT POSITION 1
QUAD 1
QUAD 2
QUAD 3
QUAD 4
SIDE "A"
SIDE "B"
lower slide "home" centered on platform
upper slide "home" extended at side B
STORED ATTITUDE OF VEHICLES

FIG. 16

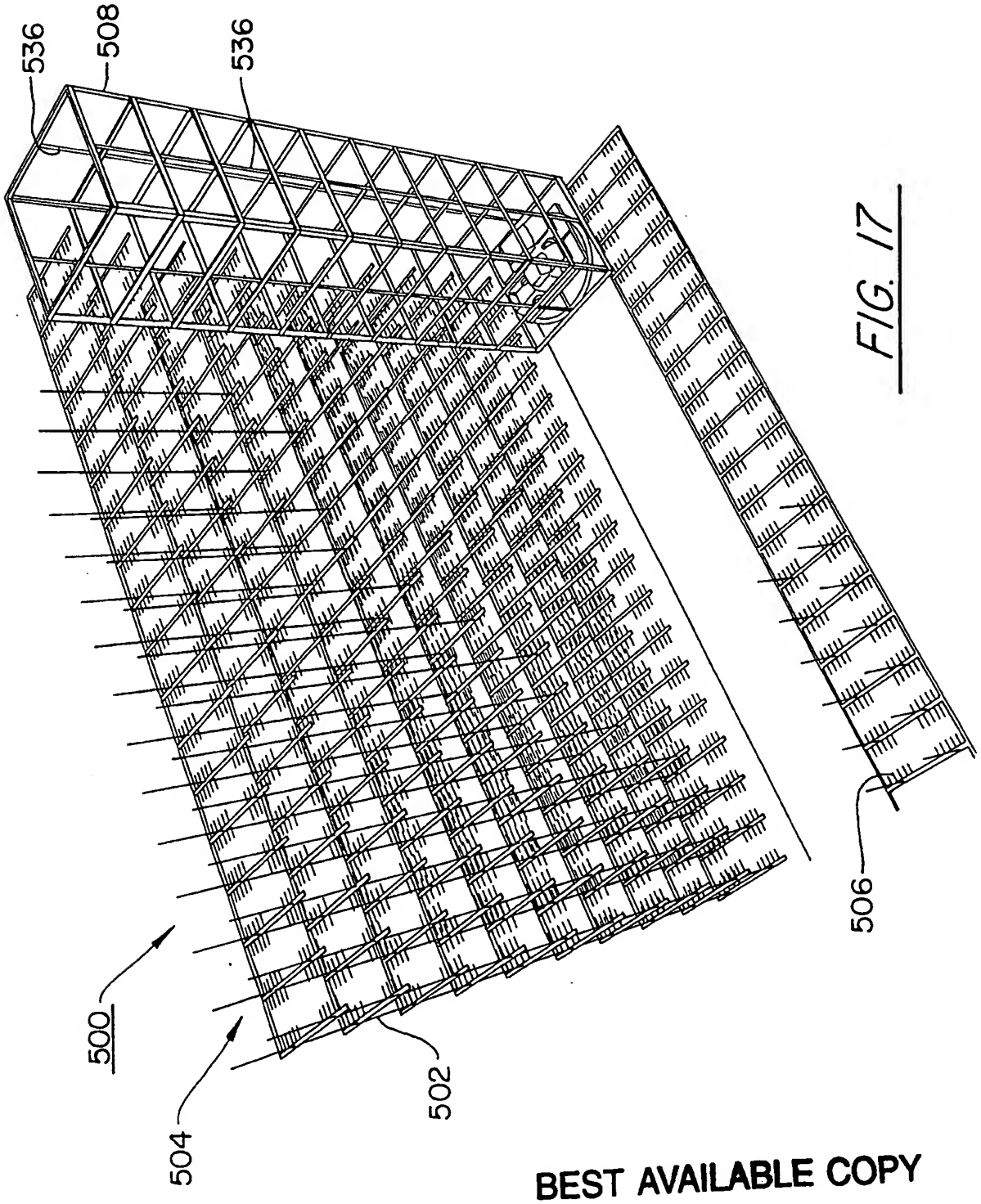

FIG. 17

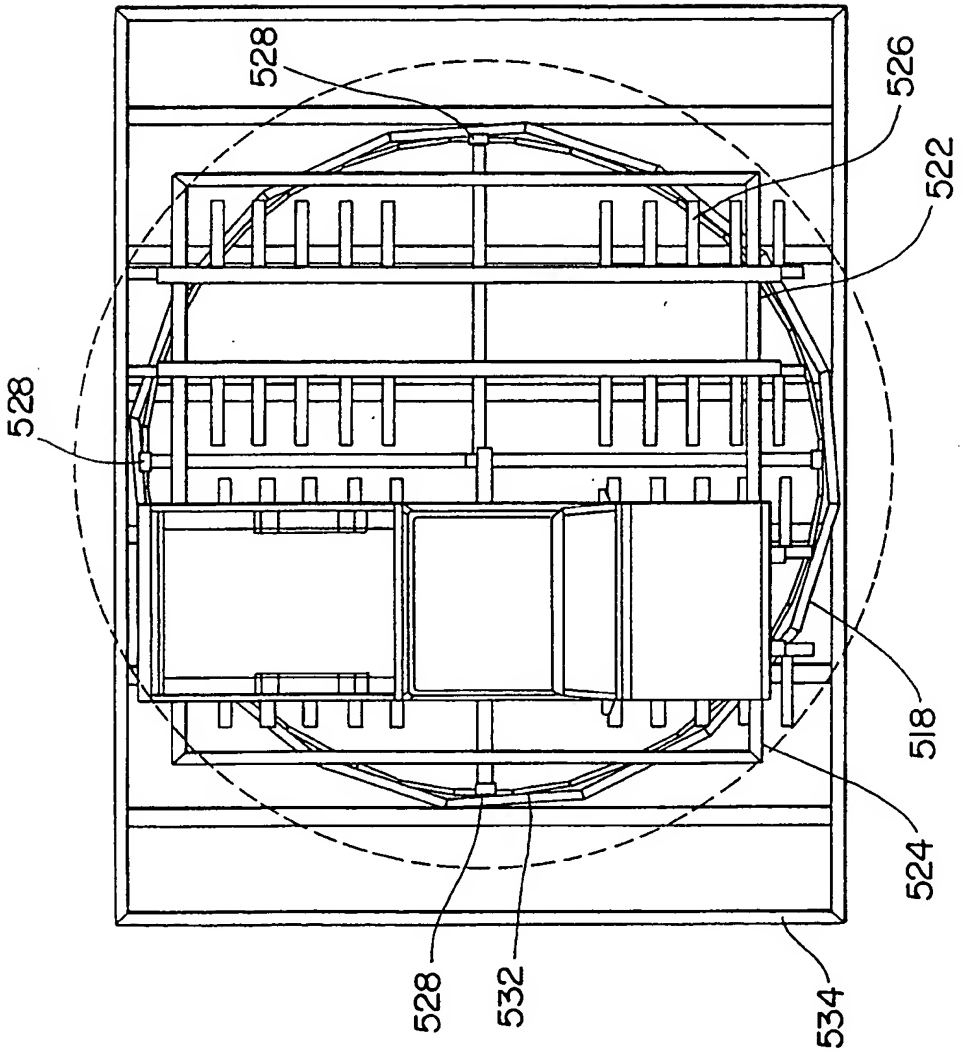

FIG. 18

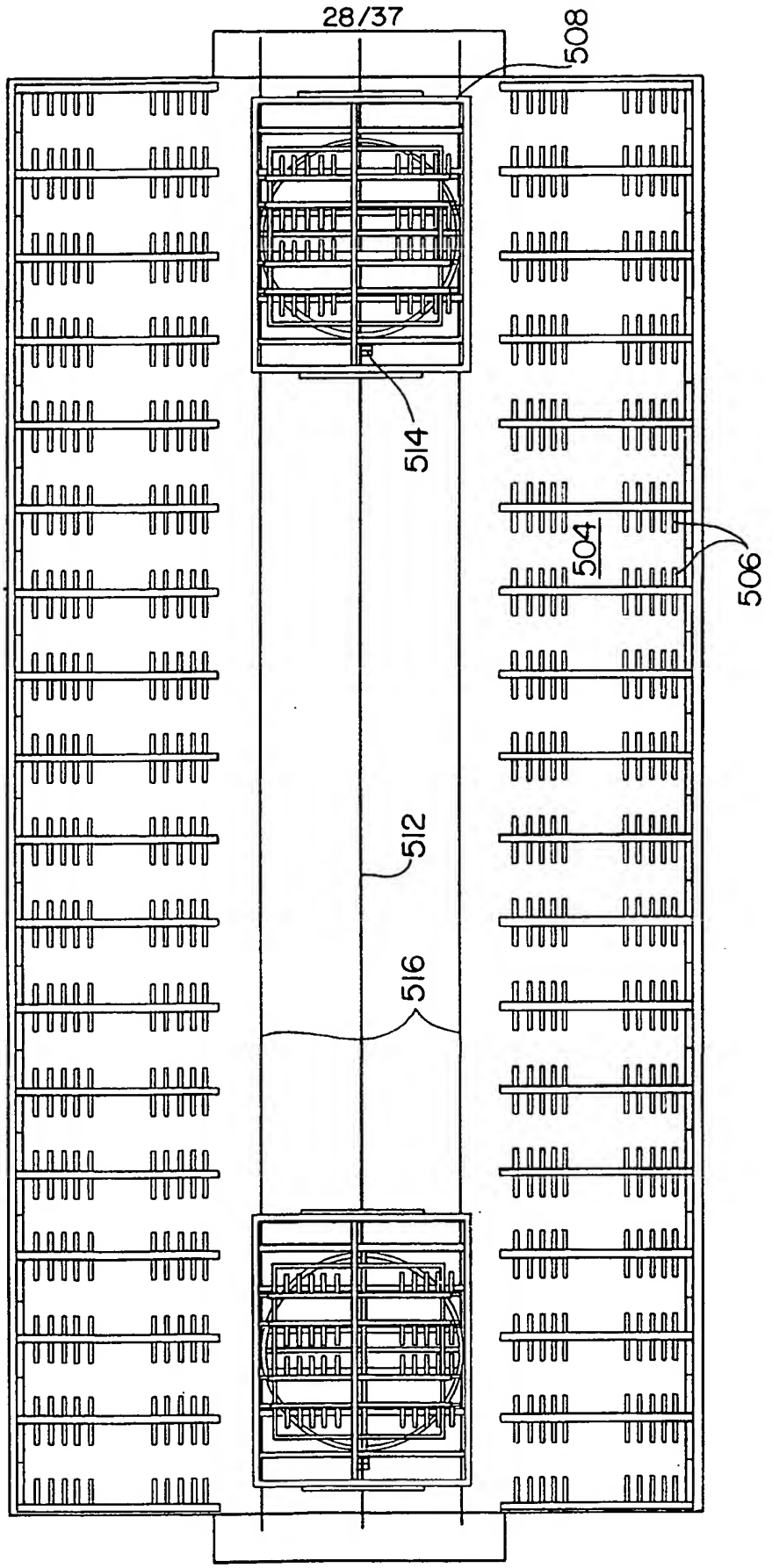

FIG. 19

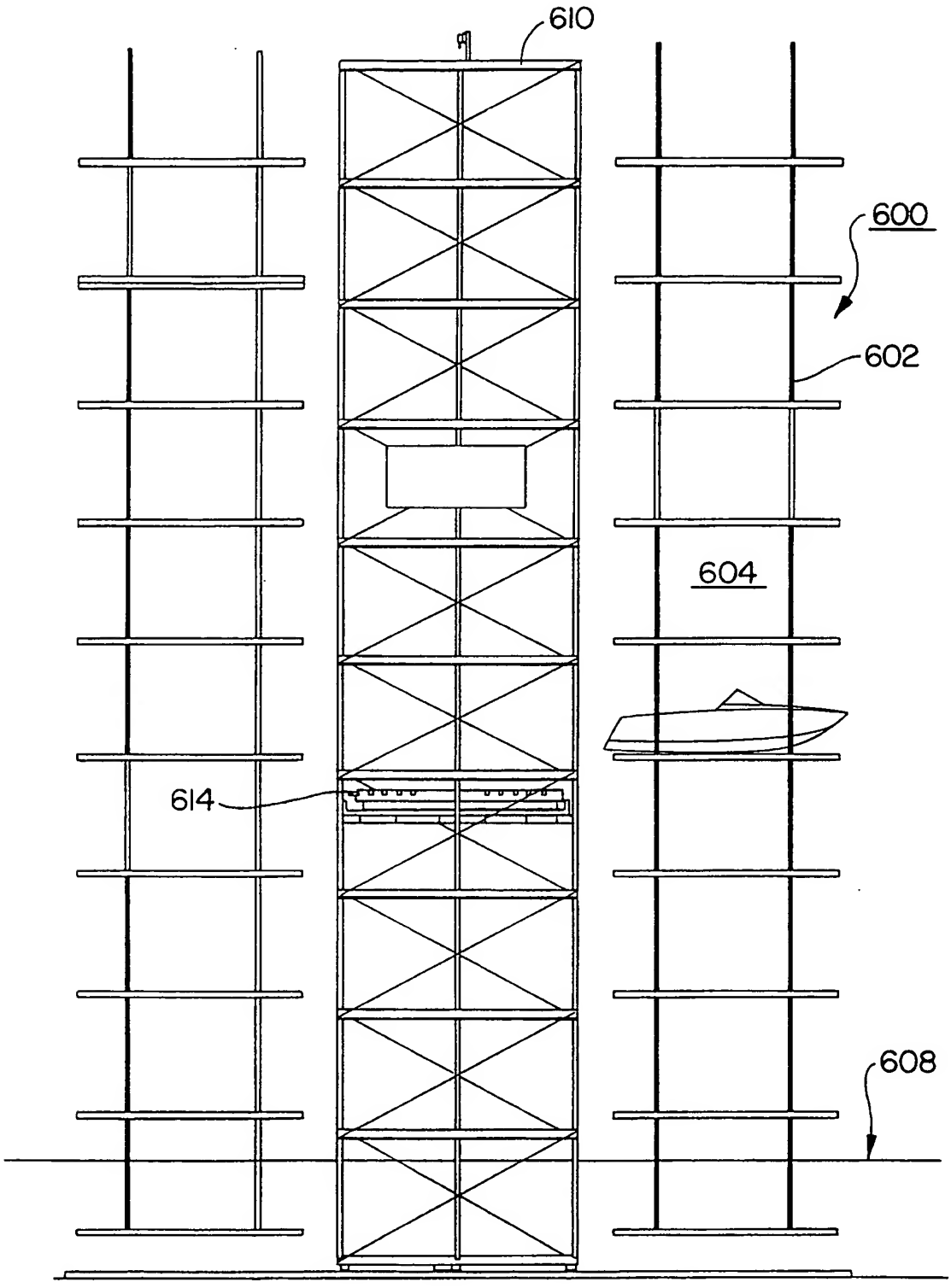

FIG. 20

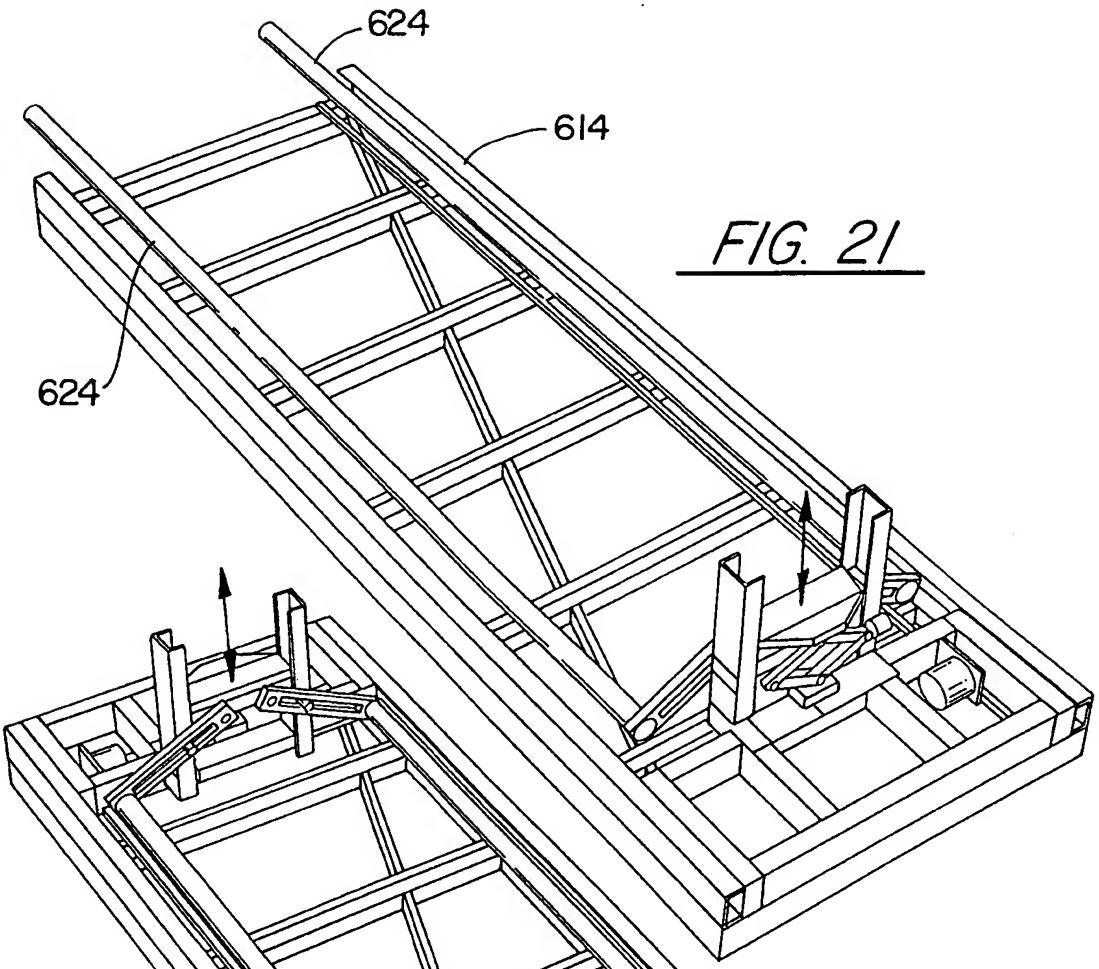

FIG. 21

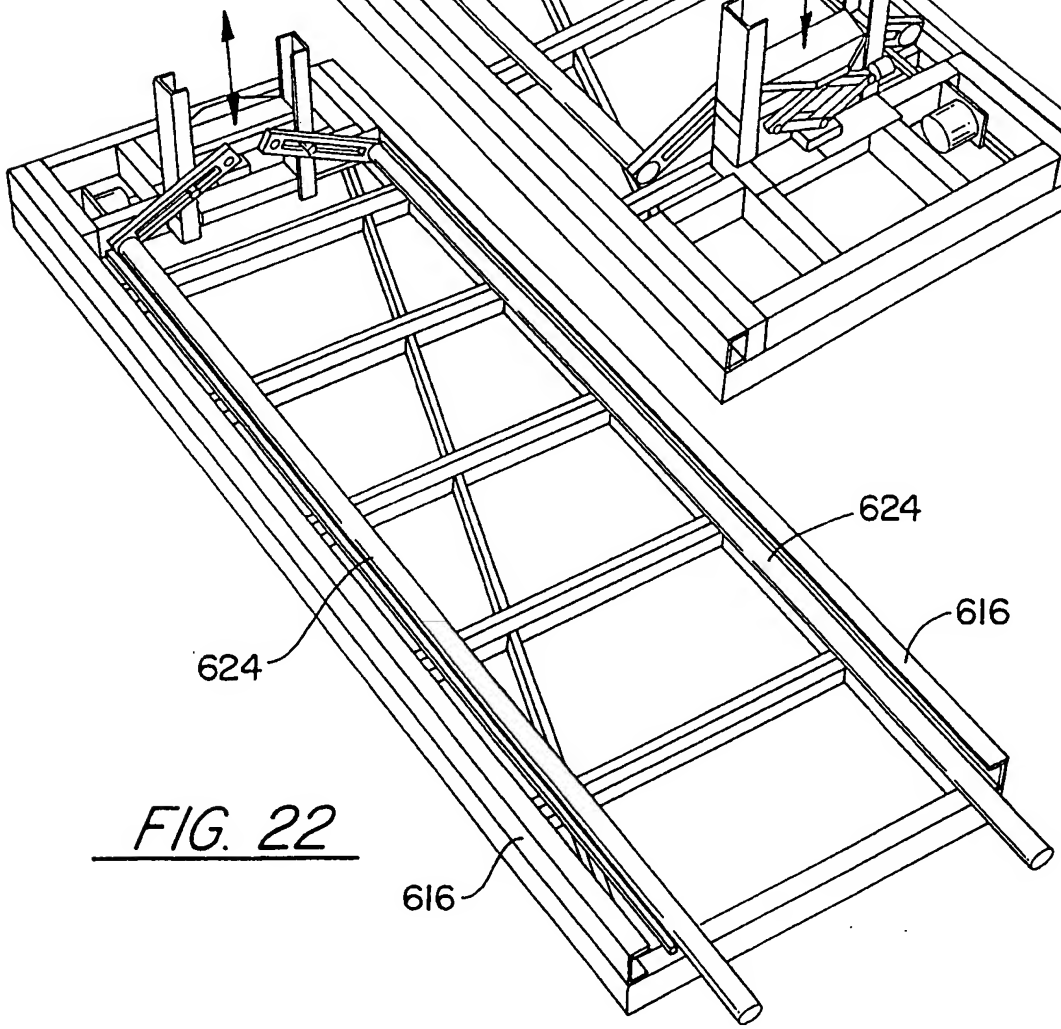

FIG. 22

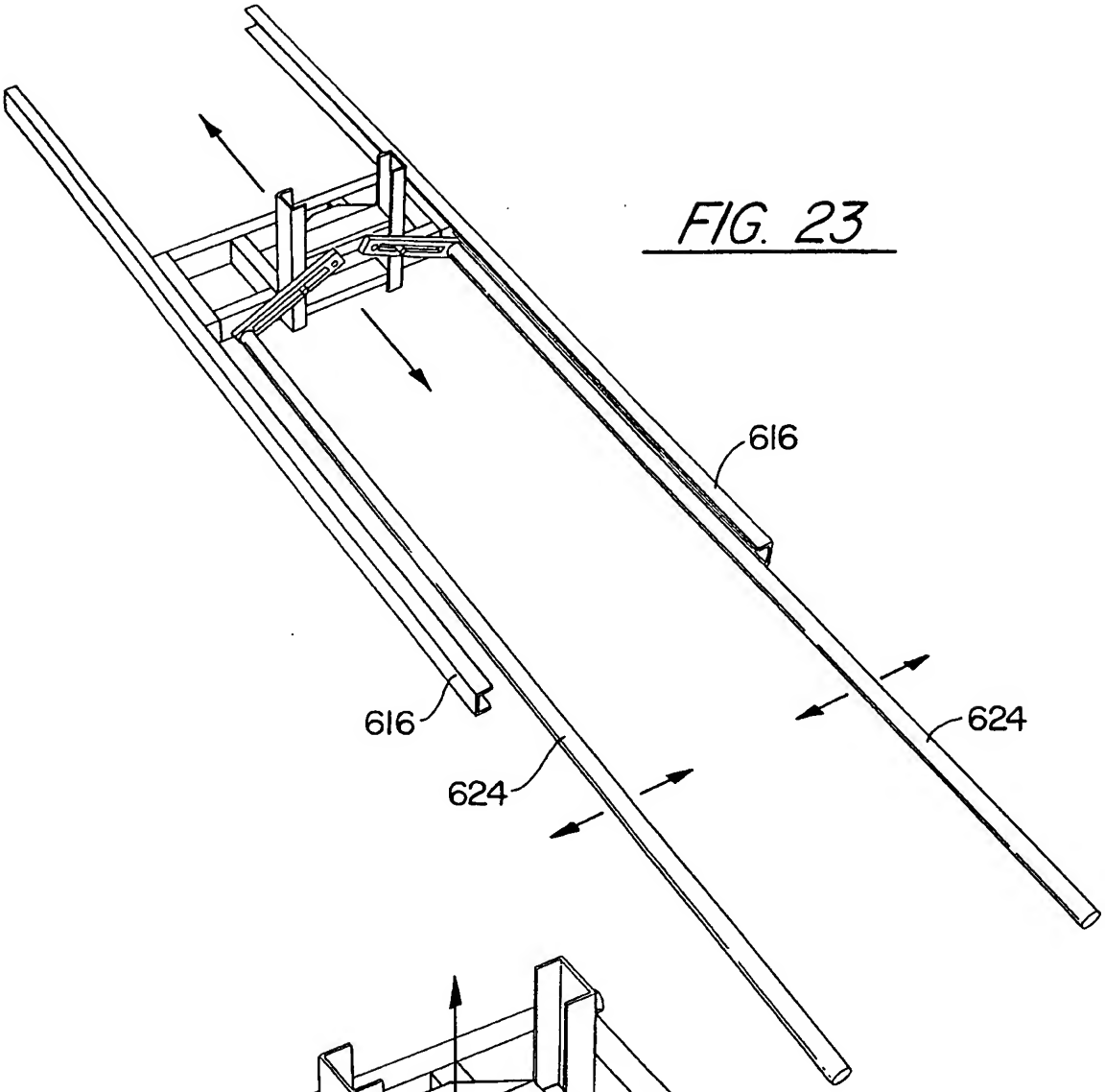

FIG. 23

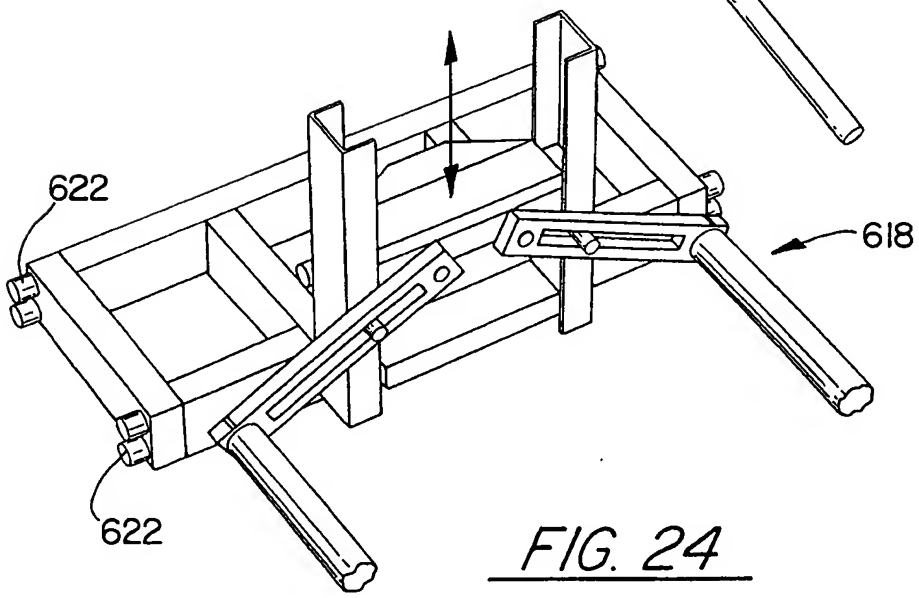

FIG. 24

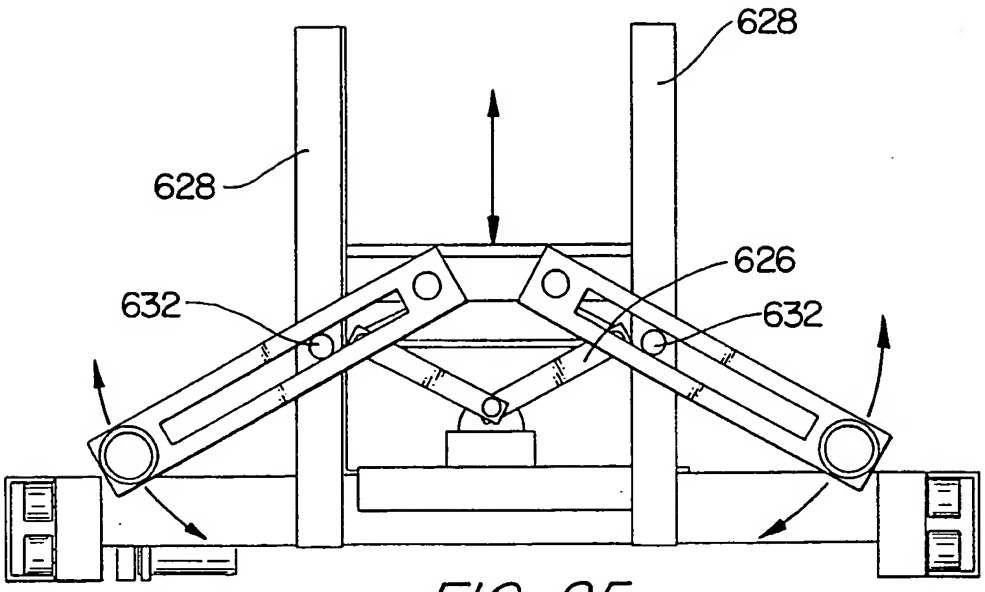

FIG. 25

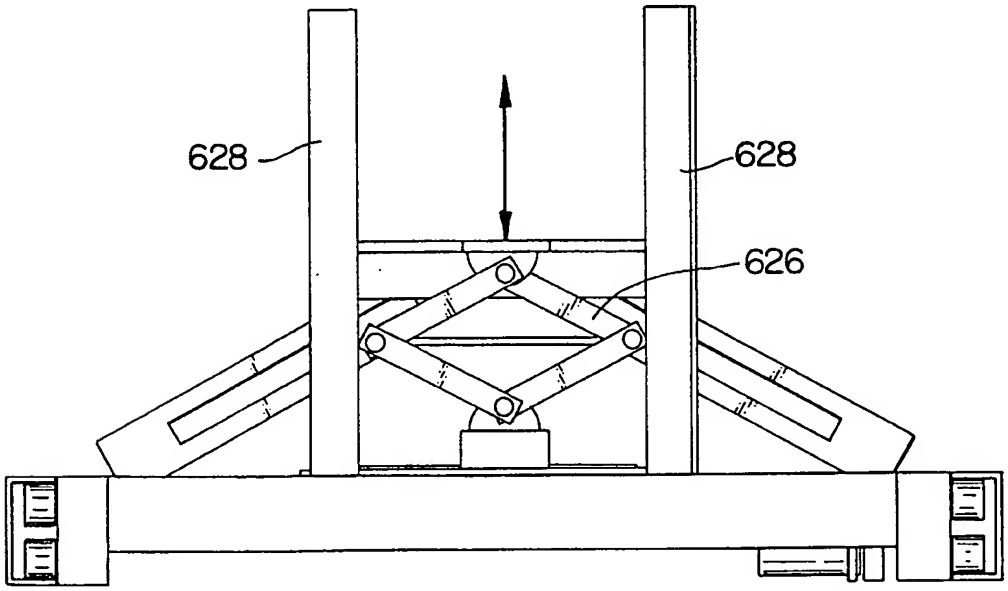

FIG. 26

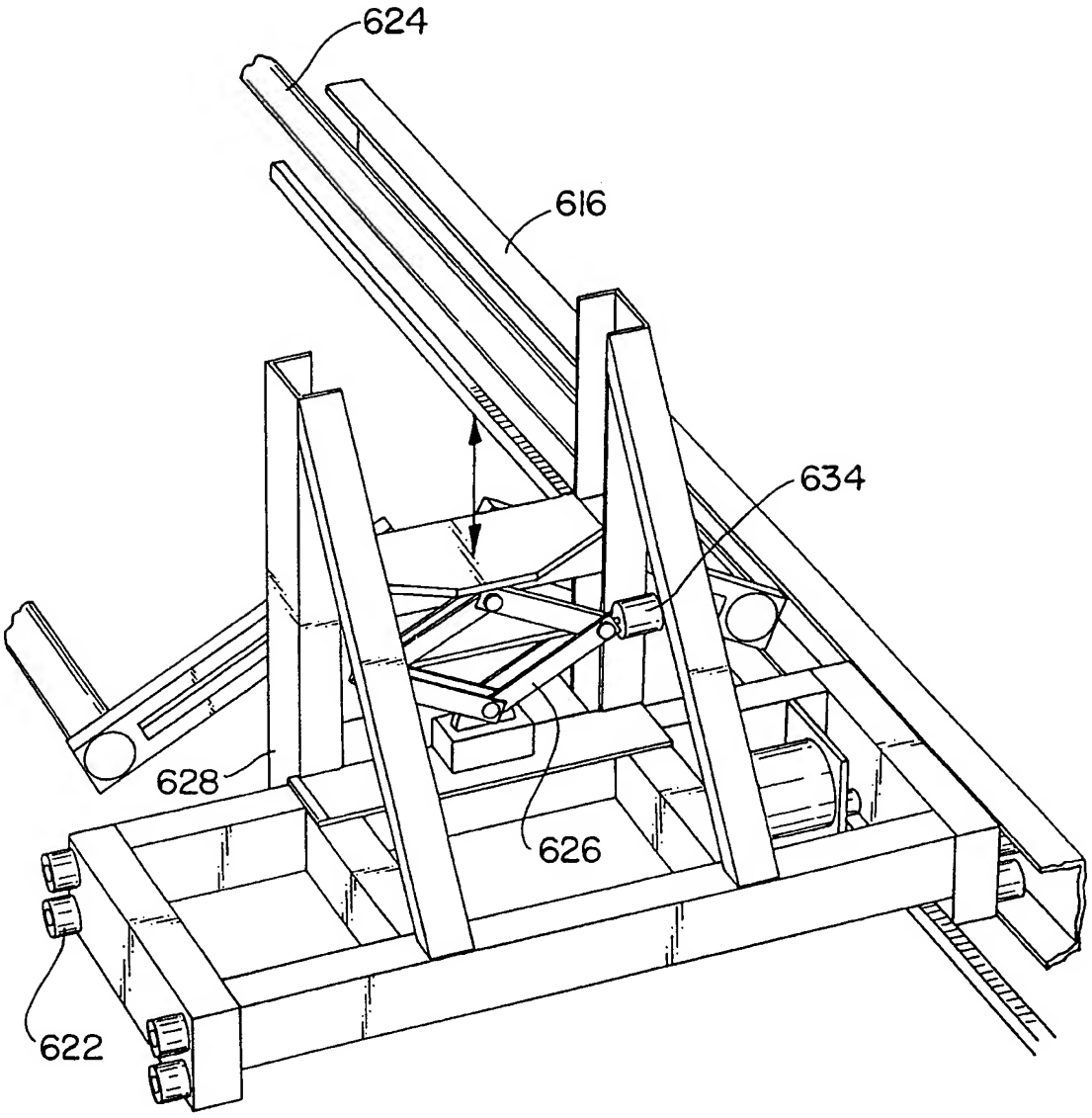

FIG. 27

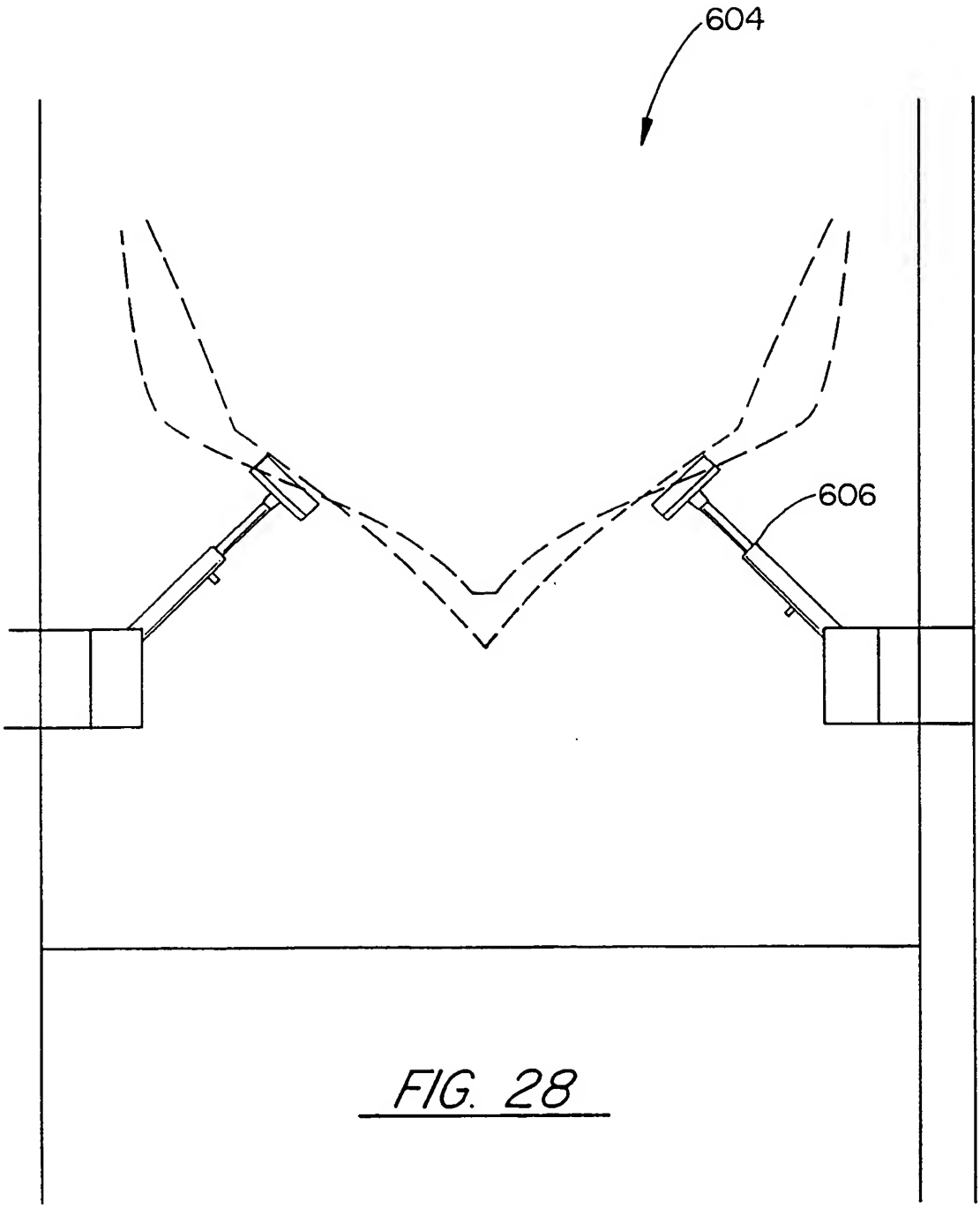

FIG. 28

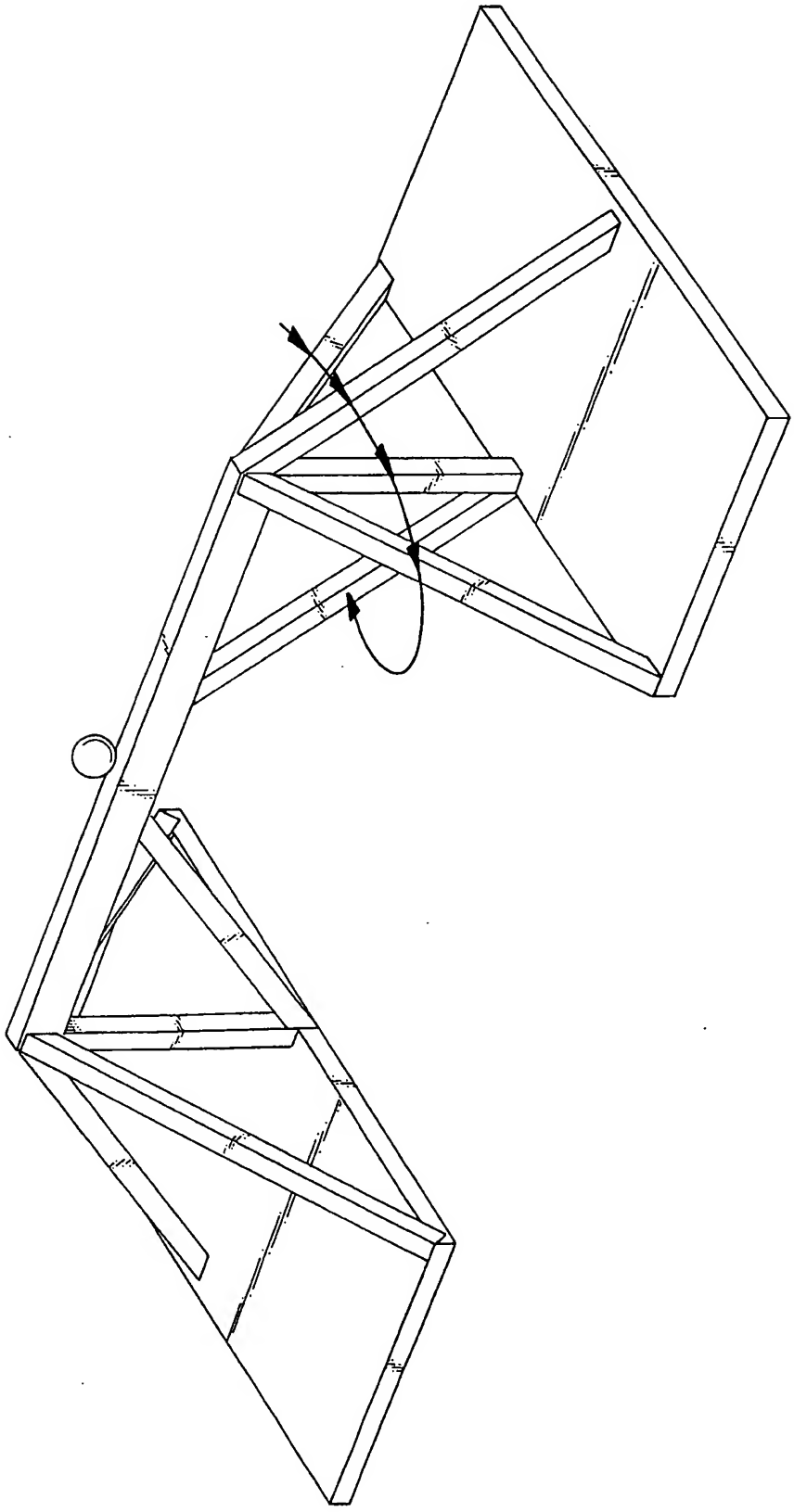

FIG. 29

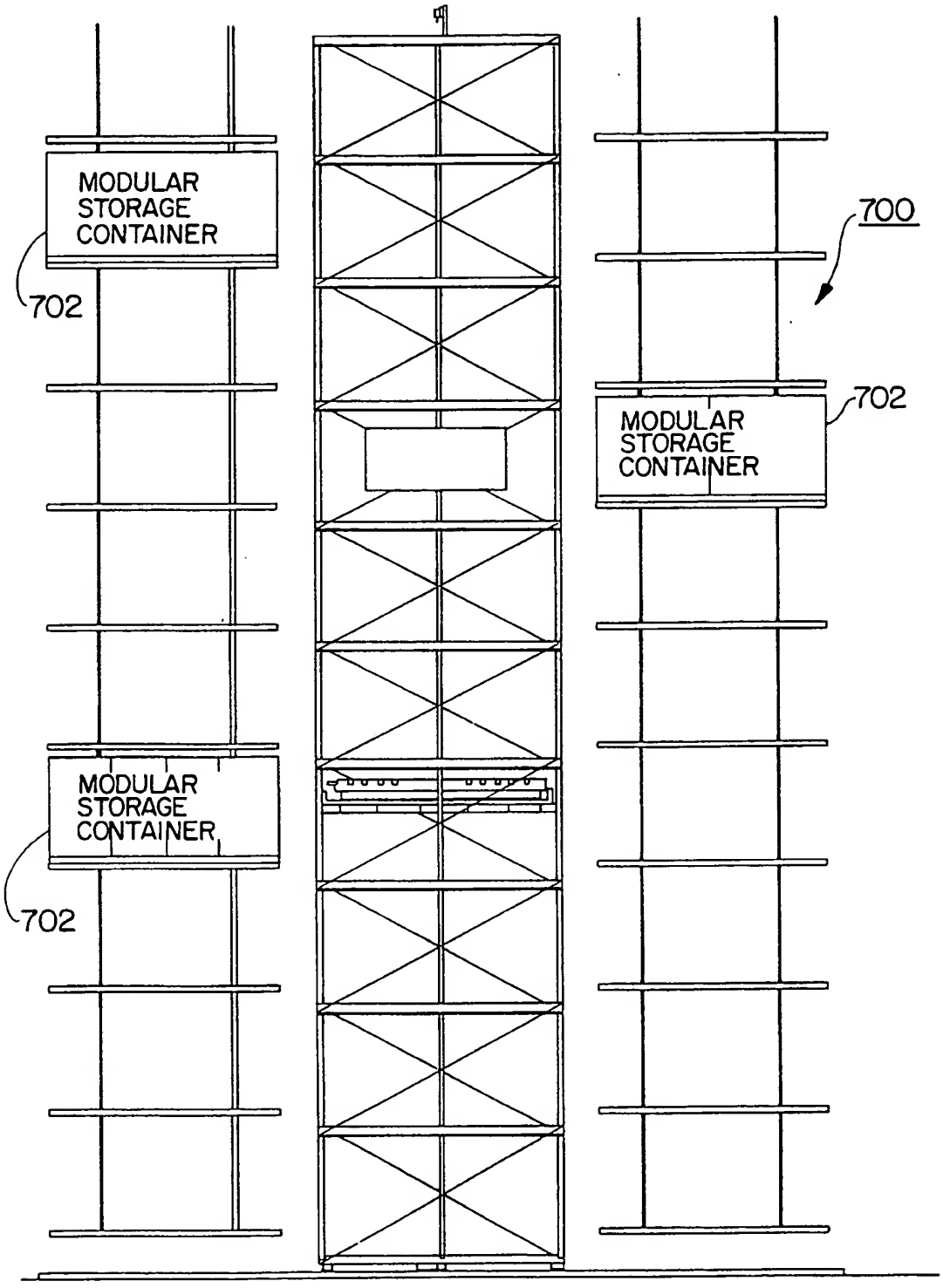
MODULAR
STORAGE
CONTAINER
702
700
MODULAR
STORAGE
CONTAINER
702
MODULAR
STORAGE
CONTAINER
702

FIG. 30

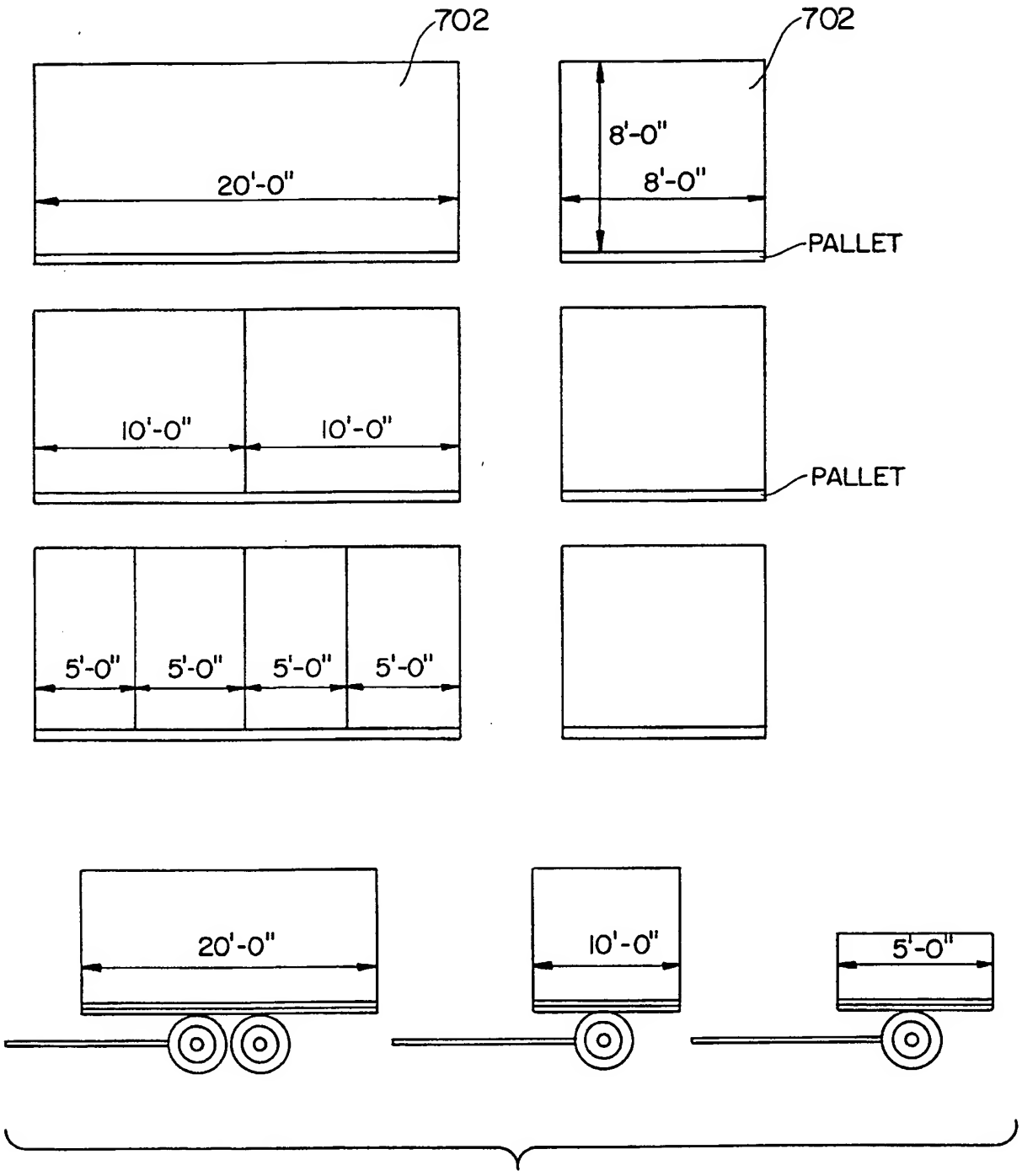

FIG. 31

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/15595

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :E04H 6/06
US CL : 414/254

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 414/254
414/231,253-256,263,264,282

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

None

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

None

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2,691,448 A (LONTZ) 12 October 1954 (12/10/54), see entire document.	1-21
Y	US 3,497,087 A (VITA) 24 February 1970 (24/02/70), see entire document.	1-21
Y	US 4,023,687 A (SALLOUM) 17 May 1977 (17/05/77), see Fig. 1.	18-21
A	US 4,594,044 A (SOOT) 10 June 1986 (10/06/86).	
Y	US 4,979,869 A (MULLIN, JR.) 25 December 1990 (25/12/90), see Fig. 3.	16,17,20, 21

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

08 SEPTEMBER 1998

Date of mailing of the international search report

16 OCT 1998

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Telephone No. (703) 308-1113

Form PCT/ISA/210 (second sheet)(July 1992)★

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/15595

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,024,571 A (SHAHAR et al.) 18 June 1991 (18/06/91).	
A	US 5,449,261 A (ROSSATO) 12 September 1995 (12/09/95).	
Y	US 5,456,562 A (SCHLECKER et al.) 10 October 1995 (10/10/95), see entire document.	1-21
A	US 5,418,723 A (REICHELT et al.) 23 May 1995 (23.05.95).	